TELE-TECH

Formerly the TELE-communications TECH-nical Section of

ELECTRONIC INDUSTRIES

MARCH, 1947

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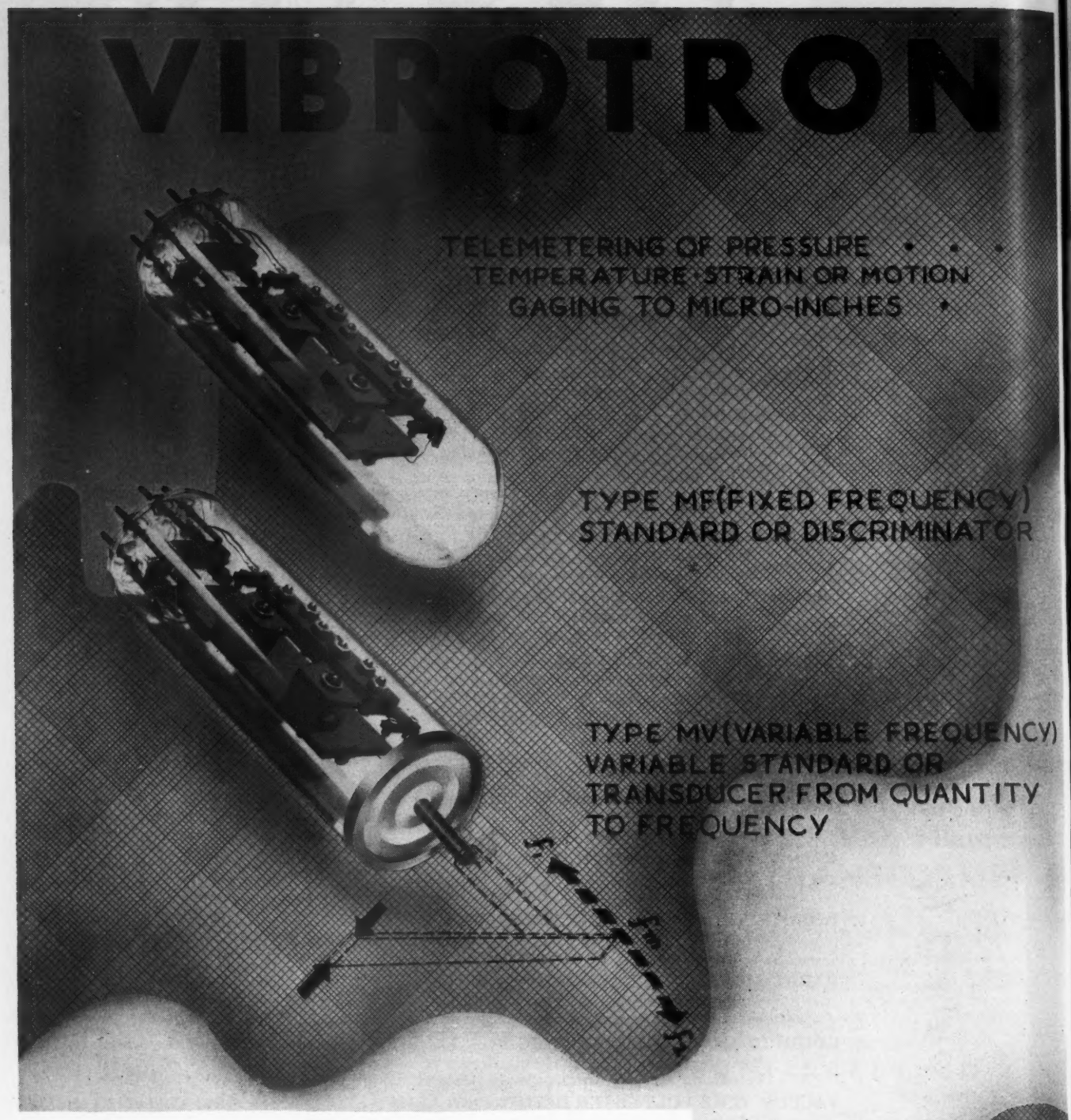
VIBROTRON



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O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.

Fast-Moving FM

Organization of the new FM Association probably marks a dividing line between FM of the past and FM of the future. From here on in, FM is earmarked for full speed ahead.

Abroad, China and Russia show signs of FM activity —the latter with two stations in Moscow. In England, Electric & Musical Industries, Ltd., has the green light to introduce FM to the British Empire. Here at home, FCC predicts nearly 700 FM stations operating by the end of 1947, largely a two-year achievement. Contrast this with some 1000 AM stations covering a period of 25 years.

To blanket the U. S., 5000 FM stations may be needed. FM receiver production is snowballing. With practically no dividends to date, venture capital continues to grow in the FM field; proof positive of the confidence in FM's looming future.

Sharing the TV Channels

Among the assorted hazards which television is facing, is the proposal that its broad channels be shared by other services which make a proper "showing of need" and non-interference.

At first it might seem that daytime interlopers might be freely permitted in the TV domain. But who knows whether television may not soon be as much of a daytime and round-the-clock service as radio broadcasting itself.

Hence the RTPB wisely considered the types of service to be permitted in the TV bands, specifying that these be (1) low power, (2) narrow band or speech, and (3) preferably point-to-point or at least a fixed service employing a directional antenna. Television—like any other baby—surely deserves to have its nursery reasonably sacrosanct until it grows up!

Radio to Aviation's Rescue

In many important respects electronics was responsible for helping win the war. It came to our rescue against submarines, night air-raids, and buzz bombs.

Again it is about to perform an important rescue mission, this time for the air transportation industry. The latter is in a sick way at present. This can hardly be questioned. Traffic has fallen sharply; earnings are way down to the point where several carriers are asking the government for financial help to carry on under the mail-contract legislation.

That this condition is due to loss of public confidence also is evident. But electronic landing and air navigating methods are in process of installation—methods which proved themselves during the war. Other methods are being developed in laboratories and on proving grounds. Eventually these aids will eliminate the air bottlenecks and dangers which underlie public fears. As adopted, these new aids will permit resumption of the forward march of air transportation.

Life Marches On!

Readers, this is the truth. It is vouched for by no less an authority than the Army Signal Association. Some recruit very much interested in "soldiering" must have started the rumor that operating radar sets not only made you blind, but sterile as well—on account of all the X-rays and other dangerous radiations flying about in the vicinity of the operators' positions.

We are happy to be able to reassure our engineer friends. After exhaustive statistical tests the Signal Corps found no significant difference in eyesight between operators and non-operators. If anything, the former had a slight edge on their non-technical brethren. Also, breathe easily, bridegroom, they had just as many healthy children!!

Large Color Chart Supplement Sent You with This Issue

AIR NAVIGATION AND LANDING SYSTEMS

To serve as a record of the decision of PICAO—of great importance in aviation—a chart is included in this issue showing engineering details of some of the systems picked out by this organization for aiding air navigation and landing.

Repeater station tower at Ten-Mile Run

2,000 Telegrams per M

By COL. J. Z. MILLAR, Radio Research Engineer
Western Union Telegraph Co., New York

Technical details of beamed Multiplex and Varioplex systems operating at frequencies up to 11,500 mc

ONE of the most revolutionary advances in telegraph engineering is the application of super-high-frequency radio methods to the transmission of Western Union messages. During the next five years, the establishment of radio beam telegraphy between the major cities of the United States is planned. These radio links will replace pole lines which have higher maintenance and replacement cost, and will provide a vastly increased number of telegraph channels. They will also improve service by virtually eliminating circuit interruptions caused by storms and other electrical disturbances. This policy is the result of highly successful experiments culminating in the regular daily transmission of commercial telegrams over a microwave system during the past several months[1].

• The first practical microwave system for transmitting a large number of messages was constructed between New York and Philadelphia in the spring of 1945. The RCA-Victor Division of Radio Corporation of America engineered and installed the radio equipment, while Western Union provided the terminal facilities including voice band translation apparatus and telegraph carrier channels. The frequency was near 4000 mc. In July, 1946, the original test apparatus was replaced by factory-made equipment of latest design[2].

While this plan is being adapted first to long distance communication, with relay stations using parabolic reflectors every 25 to 60 miles, it may be mentioned that radio beam telegraphy is not restricted to such long distance circuits. Engineers are not overlooking the possibility of using radio transmission to reach local areas and way points.

In another development, which would use somewhat longer waves, contact can be maintained between the central office and specially-equipped vehicles cruising local areas and delivering telegrams directly to the customer.

Western Union has also conducted simultaneous comparative propagation tests between Neshanic, N. J., and New York using several frequencies to obtain continuous long time records of signal strength. These records will be used to select the best of the following frequency bands which have been tentatively allocated to common carrier operation by the FCC: 3700-4200 mc.; 5850-6350 mc.; 10,500-11,500 mc.

Terminal Equipment

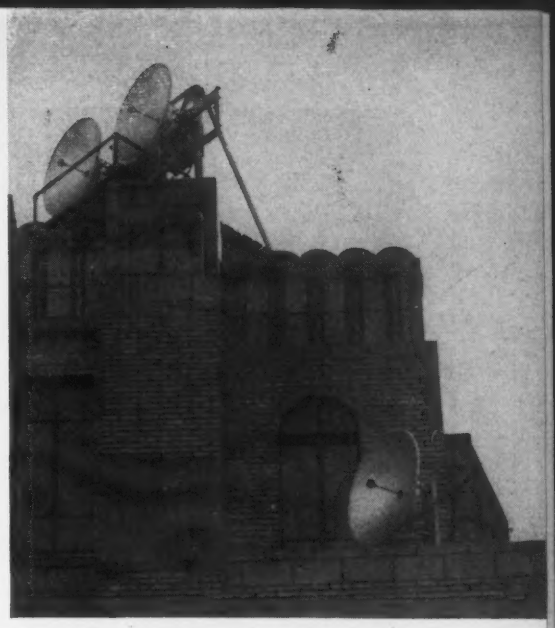
A few words concerning the types of telegraph equipment usually connected at the ends of typical circuits will serve to give the reader a clearer picture of Western Union practice. Even though the tendency for the past 40 years has been toward mechanization, a number of manually-operated Morse circuits still are in use. Next, Teleprinters (using the start-stop method of operation) are used extensively between main and branch offices and in customers' offices.

The heaviest loads which occur on long distance trunk lines, however, are carried over the "Multiplex." In this system four printer sub-channels are interlaced by time division. Advantage can then be taken of the available high line signaling speed while holding each printer down to its normal speed of 65 to 75 words per minute.

A variation of the Multiplex is the Varioplex which provides for the channeling of as many as 40 widely separated Teleprinters over a single Multiplex system. In the Varioplex, if more than four terminal stations become active, the total capacity of the system is shared equally between those desiring to transmit.

Since 1937, frequency-modulated telegraph carriers have been used. Fig. 1 shows how voice-width bands are divided into such carrier channels. Any voice-band may be thus sub-divided, or the full bandwidth may be used for facsimile or ad-

Minute by Microwave



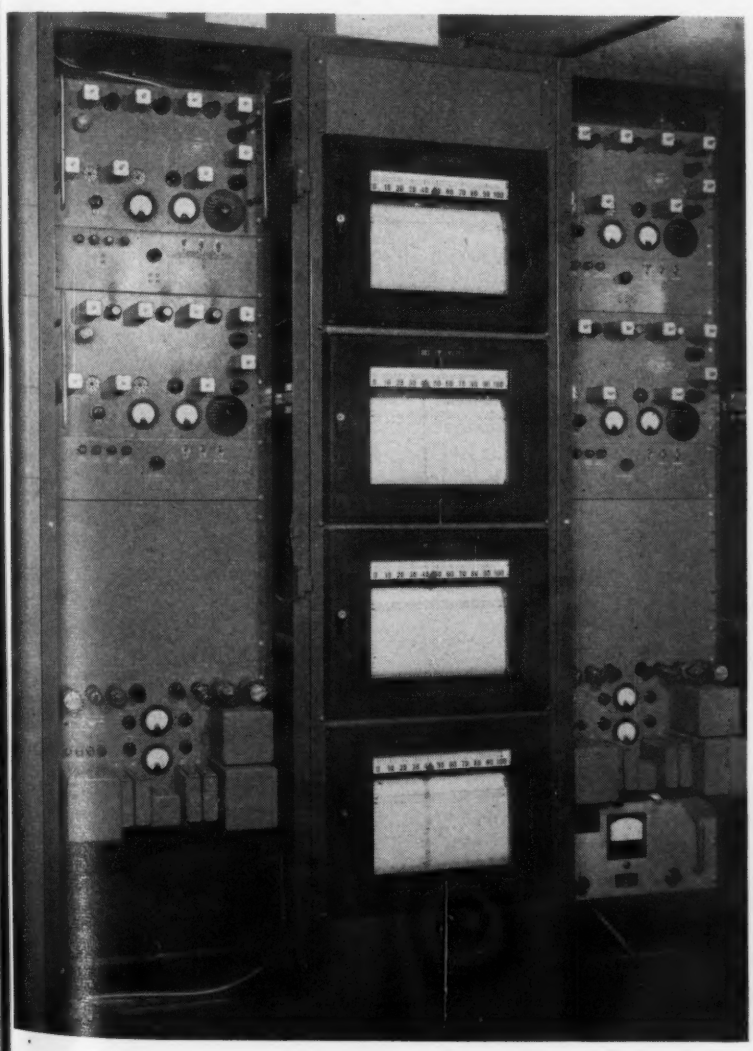
Television signal distribution amplifier antenna installation at Philadelphia end

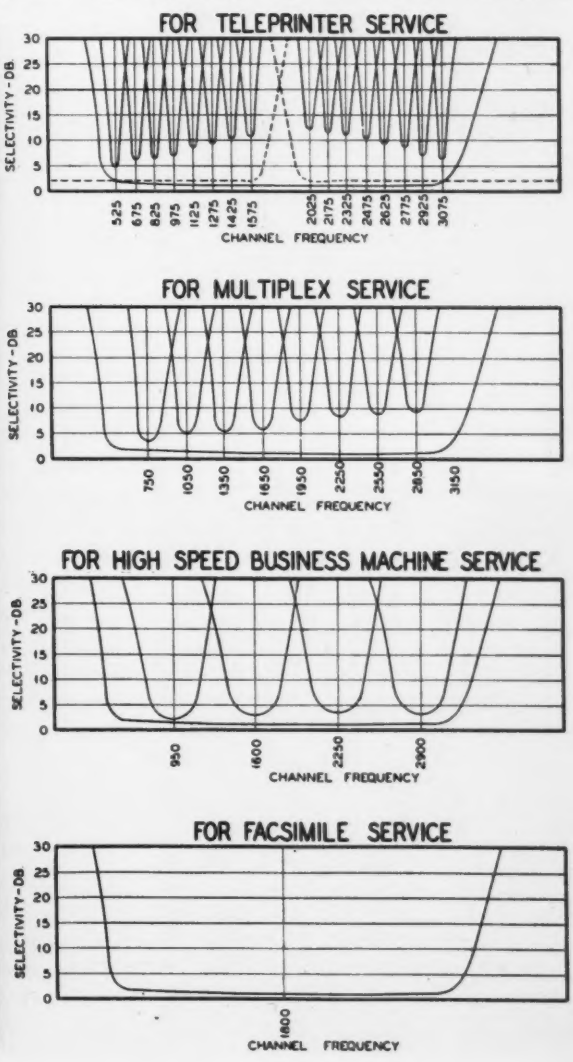
ministrative telephone service. Sixteen narrow-band telegraph channels, each satisfactory for a Morse circuit, a Teleprinter circuit, or a two-printer Multiplex circuit are obtained. The carrier frequencies are spaced 150 cycles apart and are deviated plus and minus 35 cycles by the telegraph signals. The voice bands also may be sub-divided into lesser numbers of channels for other services such as the four-printer Multiplex, the Varioplex, high-speed ticker Multiplex, or the interconnection of business machines.

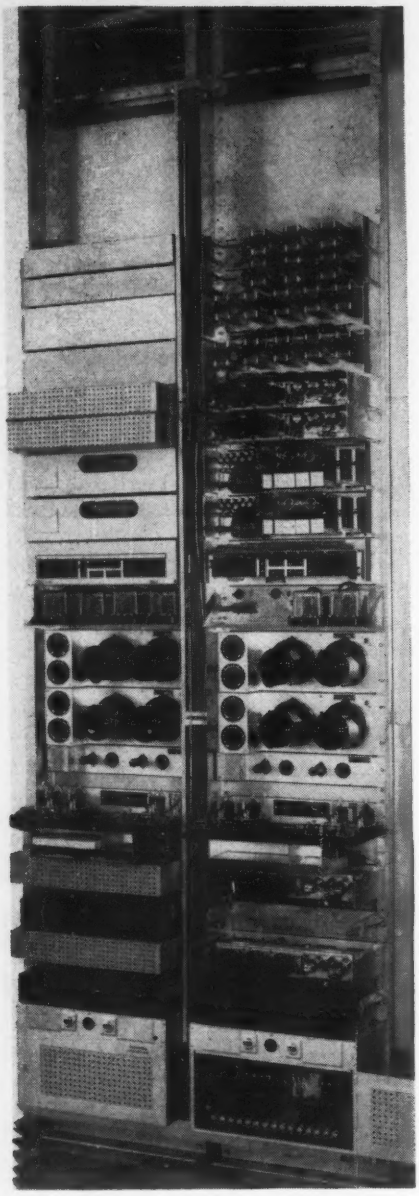
Frequency-modulated systems are less subject to rapid signal level changes and to interference effects, and consequently are freer from distortion of the telegraph signals than are amplitude modulated (on-off) systems. Thus by FM methods, the quality of signal transmission has been improved to the point where it is possible to transmit over wire circuits several thousand miles long without using regenerative telegraph repeaters.

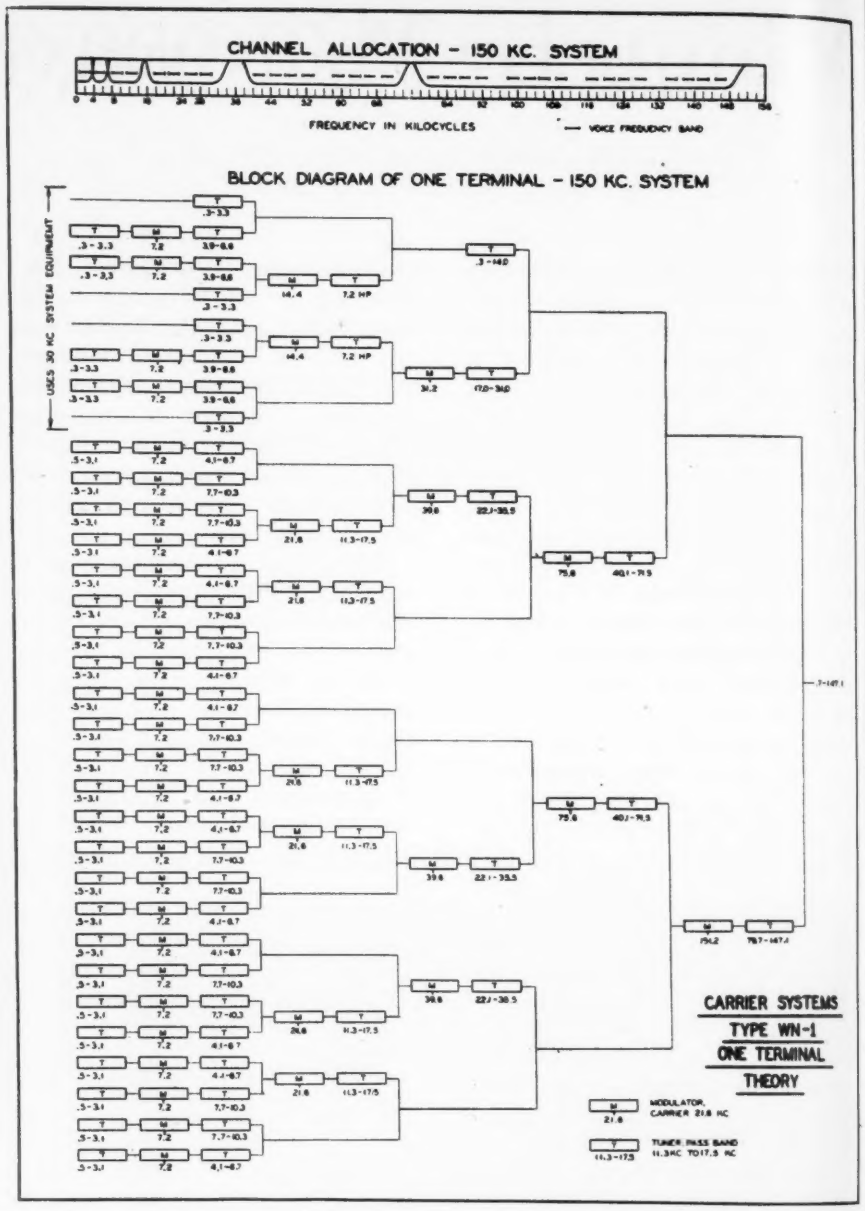
The grouping of various types of telegraph circuits into voice-bands has been found convenient for the reason that some trunk systems make use of pairs of wires for the transmission medium; others, telephone channels derived from Western Union wire carrier systems, or leased telephone circuits. And now radio beam transmission is available. Thus, grouping provides a method for translating and "stacking" voice-bands until all of the available signaling spectrum is filled. This method also facilitates the patching or switching of entire

The photograph shows the propagation test, receiving and recording equipment. Fig. 1—(Below) Voice-band sub-division plan








CHANNEL ALLOCATION - 150 KC. SYSTEM
FREQUENCY IN KILOCYCLES
VOICE FREQUENCY BAND
BLOCK DIAGRAM OF ONE TERMINAL - 150 KC. SYSTEM
USES 30 KC SYSTEM EQUIPMENT
CARRIER SYSTEMS
TYPE WN-1
ONE TERMINAL
THEORY
MODULATOR, CARRIER 21.8 KC
TUNER PASS BAND 11.3 KC TO 17.5 KC

Four telegraph carrier channel terminals with covers removed to show equipment. **Fig. 2—(Above) WN-1 carrier system block**

Weatherproof microwave equipment cabinet used for remote amplifiers

groups of circuits in case of failure without reconnecting each telegraph channel individually.

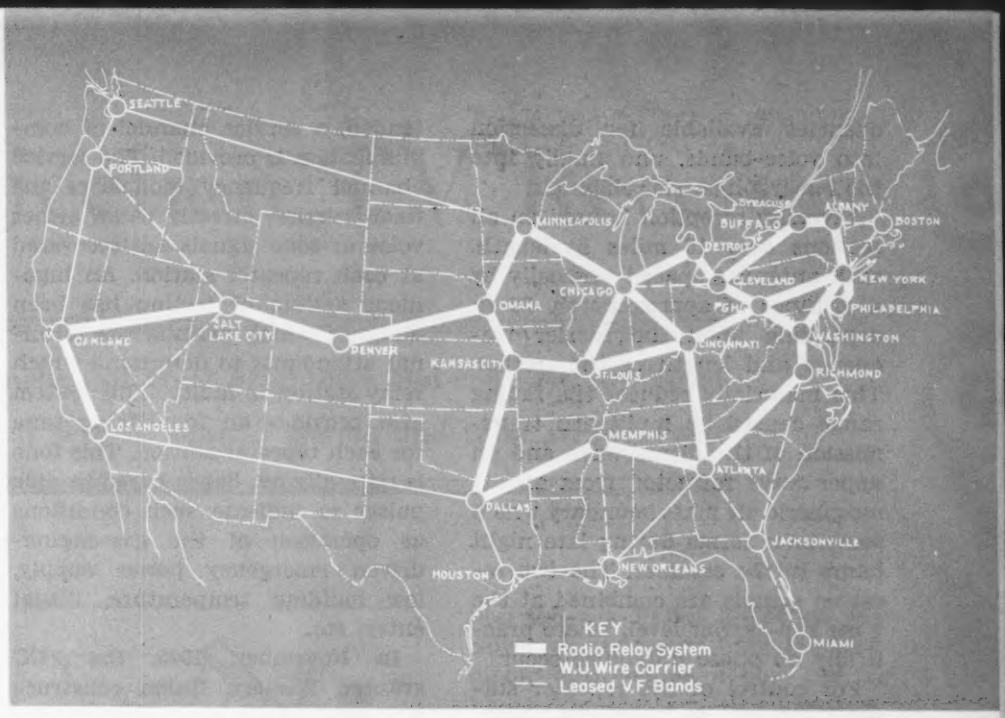
The largest bandwidth utilized in Western Union wire line practice is approximately 32 kc. which is sufficient frequency spectrum to provide 8 two-way voice-bands (on a four-wire basis). Following this practice it was decided to design the initial radio beam for 32 voice-bands and increase the number of systems for any required capacity over this value. This number of voice-bands would result in a total capacity of 2048 simultaneous transmissions, half in one direction and half in the other, and since each telegram requires about one minute for transmission, each office could receive over 1000 messages per minute.

In its present networks, large as they are, Western Union does not immediately require all this intercity capacity. Therefore, approximately half of the available voice-bands will be reserved for alternate route transmission. The anticipated growth of Telefax will require many additional voice-bands, but these can be provided for by the establishment of additional beam systems.

Fig. 2 shows the arrangement of tuners and modulators used to translate the 32 voice-bands to appropriate positions in the spectrum. This is a single side band suppressed-carrier system. For such a scheme, it is necessary that the base oscillators from which the modulator frequencies are obtained be precise, otherwise the telegraph carrier frequencies sent by a ter-

minal would not fall within the discriminator characteristics at the receiving terminal. Also, the amplitude-frequency characteristics and the total distortion within each derived voice-band must be held to reasonable limits, and the signal-to-noise ratio should be greater than 35 db. It will be noted that a signaling spectrum of 150 kc is required.

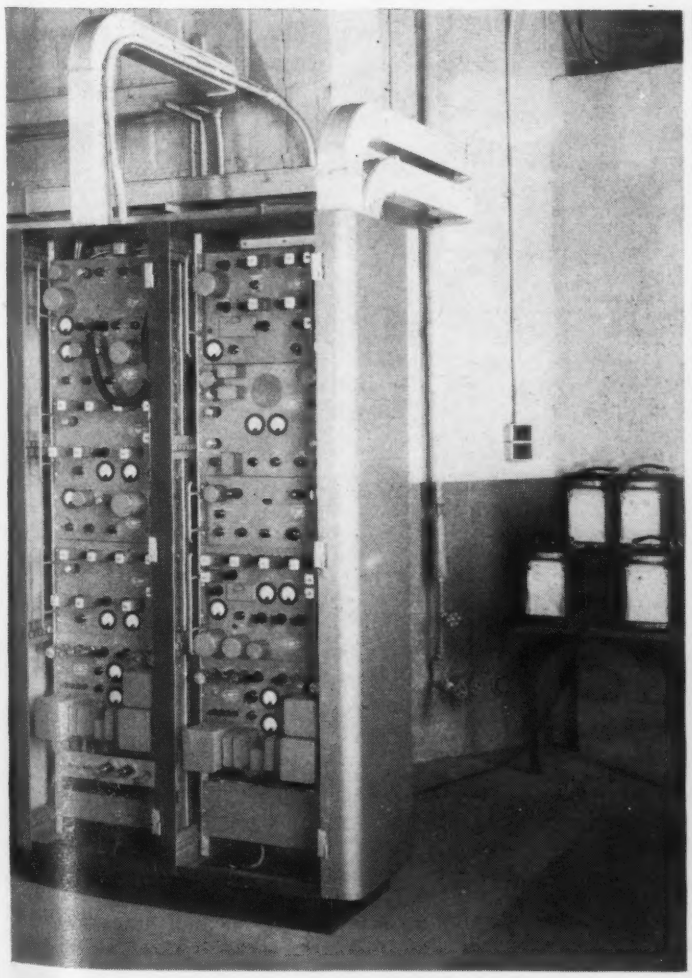
In the radio link it is important to have low distortion to avoid crosstalk between voice-bands. The system which met the distortion and other wideband transmission requirements best was the invention of Leland E. Thompson of RCA[3]. In this system, a wide signaling frequency band of 150 kc is handled with a signal-to-noise ratio of 53 db in each derived voice band and a distortion of less than a few tenths of a per cent, the exact amount depending upon the number of repeaters. Double modulation is used, that is, the 150 kc band of input frequencies from the voice-band equipment frequency-phase modulates a 1 mc sub-carrier, and this sub-carrier in turn frequency modulates the final carrier, for example, 4000 mc.

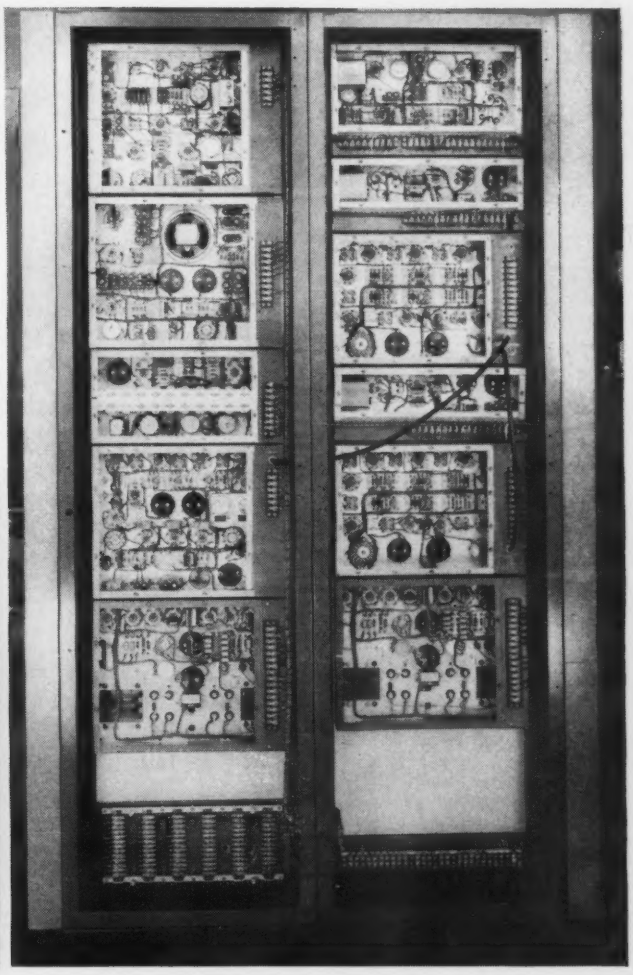


Map diagram showing proposed Western Union radio relay system and trunks

At each repeater the received signal is heterodyned to an intermediate frequency of 32 mc. and after amplification and limiting, the signal is demodulated by passing it through a discriminator. The derived output is the 1 mc sub-carrier which then modulates the on-going transmitter. Double demodulation is used only at the receiving terminal, thus making the original input fre-

Left is a view of New York terminal station equipment racks with covers removed and (right) back of racks with covers off





quencies available for dissection into voice-bands, and finally into the telegraph carrier channels.

Diversity reception is used on all sections over 15 miles in length, with antennas spaced vertically by a distance of approximately 25 ft. depending upon the carrier frequency and length of the section. This materially reduces the fading range caused by multipath transmission of the direct wave and an upper wave refracted from an atmospheric air mass boundary which sometimes forms during late night hours in the summer. The two received signals are combined at the 1 mc sub-carrier level, where practically no phase difference occurs.

For control of the repeater stations, which are normally unattended, a service channel of communication is provided. The service channel frequency modulates the final carrier directly, and either voice or tone signals are recovered at each repeater station. An ingenious system of testing has been designed which permits the terminal attendants to determine which relay station is faulty. This system also provides an identifying tone for each repeater station. This tone is normally off, but is keyed in code pulses to indicate such conditions as operation of the gas-engine-driven emergency power supply, low building temperature, illegal entry, etc.

In November, 1945, the FCC granted Western Union construction permits for a network of stations arranged to connect New York, Washington and Pittsburgh, with a second chain connecting New York and Philadelphia. Work on this system progressed satisfactorily throughout 1946, even though much delay resulted from strikes and material shortages.

Extensions of Western Union's radio operations are planned generally in the form of triangular relay systems which will replace trunk pole line facilities as soon as radio relaying becomes established on a commercial basis and existing contracts permit.

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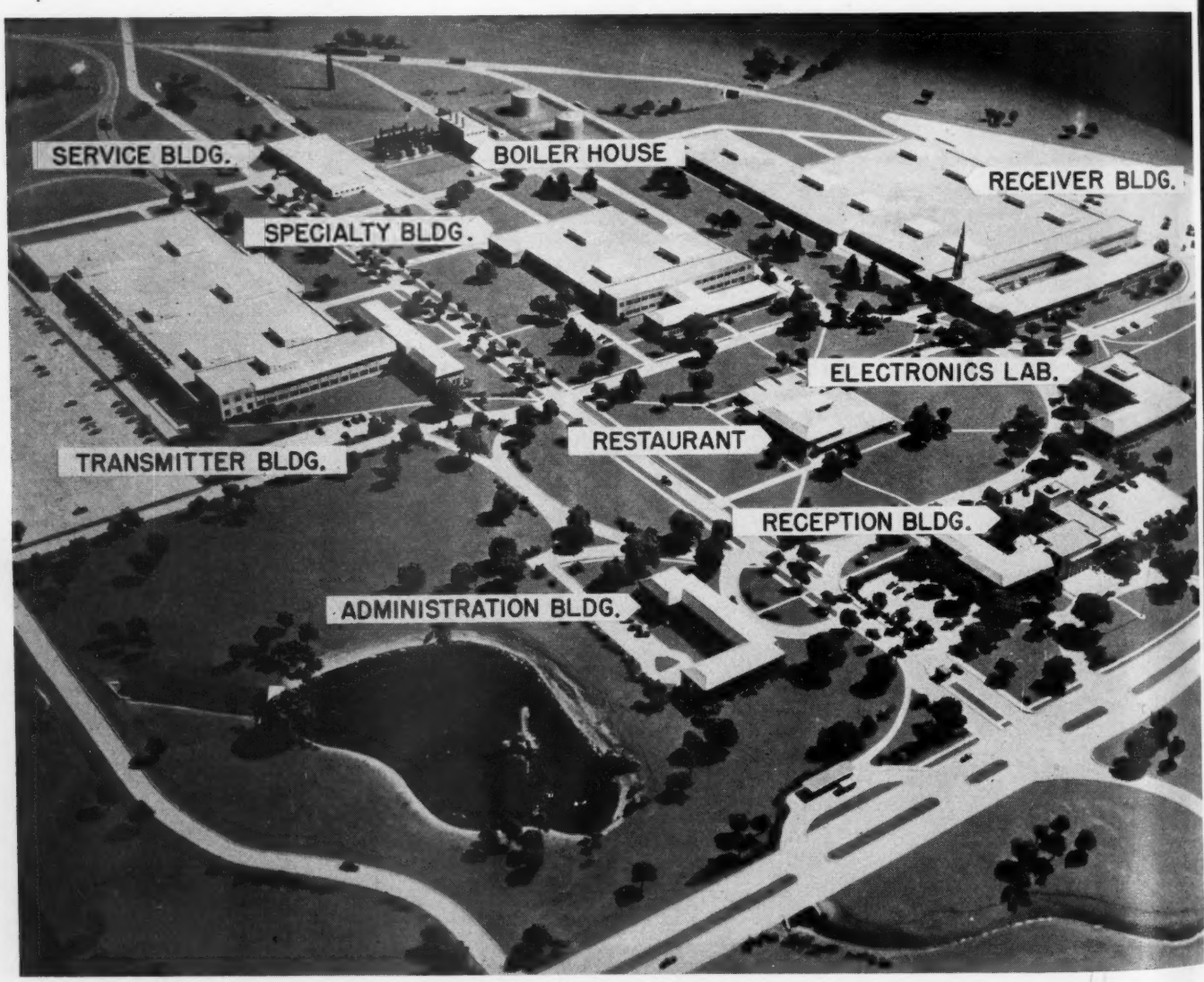
[1]A Preview of The Western Union System of Radio Beam Telegraphy, by Col. Julian Z. Millar, *Journal of the Franklin Institute.*
[2]A Microwave Relay Communication System, by G. G. Gerlach, *RCA Review,* December, 1946.
[3]A Microwave Relay System, by Leland E. Thompson, *Proceedings of the IRE,* December, 1946.

GENERAL ELECTRIC'S NEW ELECTRONICS PARK



Laid out and landscaped like a college campus, GE's new Electronics Park in Syracuse will house the main manufacturing units of electronics department. From this great aggregation of modern buildings, affording over one million square feet, will issue a myriad of products for the new world of tomorrow—television, FM, wire recording, facsimile, radar, public service

Philco Projection TV Receiver

Pictures, 15 by 20 inches, of great brightness and contrast, produced by new type inclined screen, optical system and tube arrangement

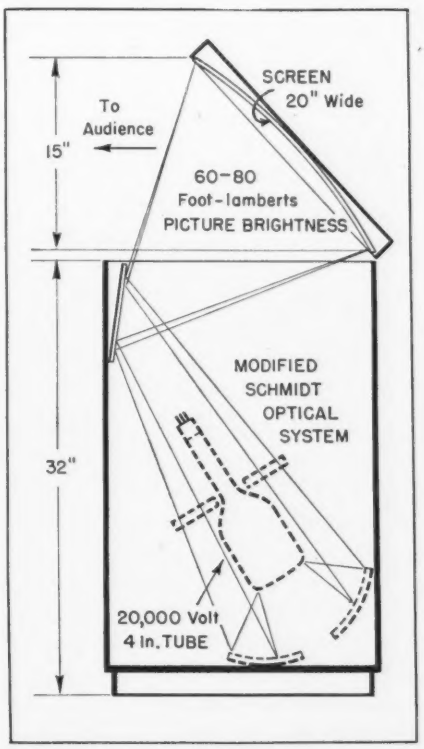
• A production model of the new Philco projection television receiver was shown in operation for ten minutes during the FCC hearing at Princeton, N. J., Jan. 29—after which the set was covered up and all inquirers warned away by police guards.

For a number of months there has been wide interest in this Philco projection set, both among engineers and throughout the television and radio industries. The set being developed in the Philadelphia laboratories during late 1946 was understood to embody many radical features, but its secrets have been closely guarded. No one outside the Philco organization apparently had even seen the set, until the day of the Princeton hearing, when the receiver—a production model—was introduced to demonstrate some points in connection with the color-flicker tests being shown to the FCC commissioners and staff.

From engineers present at the hearing, information obtained indicates that a modified Schmidt optical system (with special "askew" elements) has a 4-inch 20,000-volt projection tube. The beam from this unit is reflected from a plane mirror inside the front of the cabinet, onto the inclined high-gain specular screen on the underside of the lifted cabinet lid, as shown in the sketch.

Viewers seated or standing in front of the cabinet see a picture 15 by 20 in. in size, with a brightness of from 60 to 80 ft-lamberts. Such a picture can be viewed comfortably in a well-lighted living room.

The tipped screen with its specular surface results in velvety blacks far below the room illumination, so that pictures of great contrast and brilliancy are produced, even in brightly lighted interiors. The special directional high-intensity screen structure itself is held responsible for a four-fold amplification of picture brightness.



Light paths in new Philco projection receiver as conjectured by observers

The projection tube used has a new phosphor, estimated by Philco's vice-president in charge of engineering, David B. Smith, to produce a three-time increase of brightness. This phosphor brilliance is further increased by metallized backing giving a two-fold increase at the 20 kv-voltage. The optical system produces a five-to-one gain over prewar designs.

During the Princeton demonstration the new Philco projection receiver was operated from a folded dipole mounted on a pole 100 ft. high. The location, 45 miles from New York City, beyond the primary service area of NBC's Empire State transmitter, was also alongside a densely traveled automobile route and near the Pennsylvania Railroad's electrified tracks and an electric substation. Ignition from air-compressors operating in a quarry across the road, and interference from an airplane landing-field nearby, added to difficulties of reception during the FCC demonstration. Under these adverse circumstances the Philco projection picture at Princeton was at times shot through with white flashes.

Working at the 45-mile distance, projection-set image was estimated to have a brightness of only about 40 ft-lamberts, though still making it comfortably viewable in the lighted room, with all window shades open, sunlight streaming in and all room lights on. One engineer estimated the room illumination at the time to be 8 to 10 ft-candles.

Under normal field-strength intensities, the Philco projection set, as already stated regularly develops a picture brightness of 60 to 80 ft-lamberts, and is, of course, free of ignition interference. This 60 to 80 ft-lambert intensity of the Philco projection-set image compares with picture brightness of about 12 to 30 ft-lamberts on some current postwar models, and 1 ft-lambert on prewar models.

In explaining the introduction of the Philco receiver during the Princeton color-television hearing, vice-president Smith said:

(*Continued on page* 127)

Engineering TV Master Control Equipment

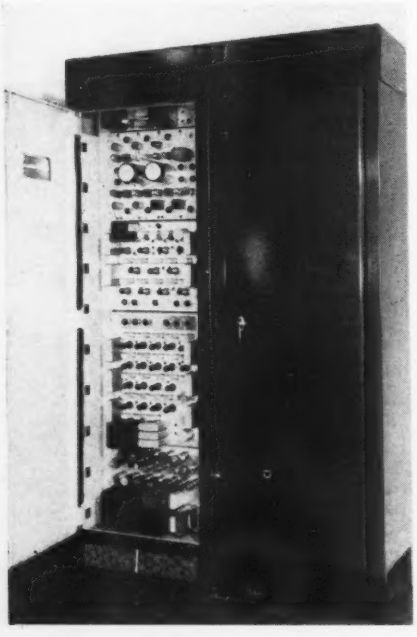
By LEONARD MAUTNER, Head, and A. J. BARACKET, Project Engineer, TV Studio Facilities Section, Allen B. DuMont Labs., Inc., Passaic, N. J.

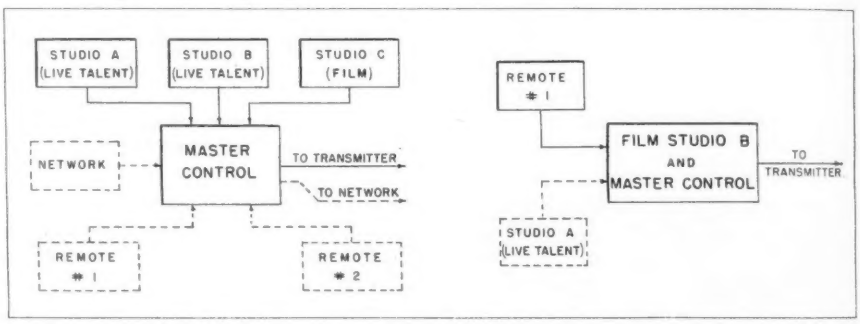
Facilities required where station operation involves more than one studio, plus remote pick-ups, as determined by current program technics

• The term Master Control in television station operations has in the past meant several different things. Generally speaking, the equipment room which has housed the synchronizing generator for a television station has been termed the "master control room" more or less independently of what other equipment was housed in the same location. In some instances the integration of film pickup facilities and master control functions has in the past seemed desirable. In others, the equipment for video shading, superposition of pictures, and allied video technics has been centralized in this location.

The expanding scope of telecasting activities, including the increased emphasis on remote and network programs, demands that re-examination be made of equipment properly constituting a Master Control assembly.

Fig. 2—RMA type synchronizing generator and distribution equipment





Figs. 1 and 3—Block diagrams of facilities required by small TV stations

EQUIPMENT complement for a typical master control for television stations is a complex problem. This article suggests five graded solutions ranging from the simplest television station to the most complete.

A typical medium sized television station installation is shown in Fig. 1. Here it is assumed that three studios are available, two for live talent operations, and a third for film pickup. Shown in dotted lines are two remote program sources typifying pickups of sports and field activities. Also indicated is a source and output for network programs; finally, the output to the station transmitter is shown.

Master Control as shown in this figure is the central control point which may accept signals from up to six sources of program material and furnish the selected information to either the transmitter, the network outlet, or both. While it is true that all these facilities will not, in general, be in use at any given time, there can exist rather involved situations which place a premium on the degree of facilities incorporated in the master control equipment.

For example, the station of Fig. 1 may be conducting a live talent program originating in Studio A, which will call upon the output of Studio C (the Film Studio) for parts of the program. An advertiser may be viewing the rehearsal of a new program, scheduled for subsequent use, emanating from Studio B. A sports event from remote source No. 1 may be the closing program. The rehearsal of a new type of remote program may also be in progress, requiring transmission of signals from remote pickup No. 2 to Master Control for distribution to client rooms, where the remote technic may be observed. Assume for these operations that no incoming network programs are involved, but that certain portions of the On-The-Air program are to be sent out to the network.

It is easy to see that a Master Control which is adequate to cope with such a typical situation will call for a relatively large complement of equipment of a fairly involved nature. It will be worthwhile to list the functions that such a Master Control must perform, and these requirements in turn will dictate the type and amount of equipment necessary. These functions will be divided into three classes: synchronizing, video, and operational functions.

Master Control Functions

A. Synchronizing Functions

1. From the synchronizing generator, utilizing the proper synchronizing signal distribution facilities, driving and blanking pulses must be fed to all local studios.
2. When supplying pulses to the various local studios, the differential delay caused by the remote location of studios from Master Control must be taken into consideration.
3. Picture signals derived from local studios must have synchronizing information added to them at Master Control before being sent out to a network or to the transmitter. Remote and incoming network programs which are furnished complete with synchronizing information must pass through Master Control without any additional synchronizing information being added.
4. Provision for phasing the synchronizing generator pulses to suit the needs of film projectors must be included.
5. When remote or network programs are contemplated, the vertical synchronizing information from these remote sources must be properly related in phase and frequency to those of the local synchronizing generator, so that switching from local to remote and from remote to local generators may be made, with no ill effects on receivers in the field. Whether it is best to operate on the local or remote synchronizing generators in this case, to achieve the desired effect, is best determined by the circumstances.

B. Video Functions

1. Facilities for the monitoring and selecting of the proper On-The-Air video channel must be incorporated so that the transmitter or network outlet may be given the required program at the correct level at the proper time.
2. Selecting and monitoring facilities must also be available for the Preview signal, which is to be next selected for On-The-Air use.
3. Monitoring and terminal facilities must be available for the servicing of incoming and outgoing network programs.
4. To facilitate the setting up of the foregoing three functions, video patch panels are furnished so that the several program sources may be properly routed through monitoring facilities to the transmitter, as well as directed to client rooms and executive offices for both On-The-Air programs and rehearsals.
5. In the case of remote and incoming network programs, the television signals as they arrive at Master Control are in frequent need of modification before they can be sent to the transmitter proper. These modifications may include expansion of the synchronizing-to-picture signal ratio and the use of line-to-line clamping technics so that extraneous signals may be removed from the television picture.

C. Operational Functions

1. Inasmuch as a variety of pro-

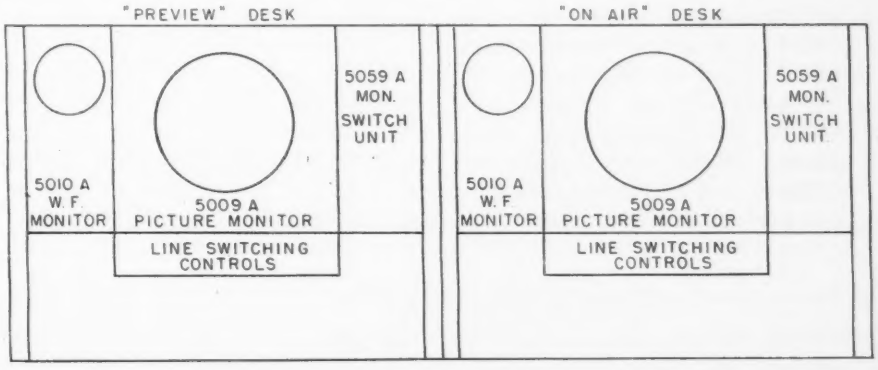


Fig. 4—Block diagram showing desks and equipment for a complete station

SYNC DISTRIBUTION POWER	# 1 SYNC GENERATOR	SYNC DISTRIBUTION	# 2 SYNC GENERATOR	REMOTE FACILITIES	"ON AIR" PICTURE	"PREVIEW" PICTURE	TEST MONITOR	PICTURE DISTRIBUTION POWER
5061 A SYNC EQUIPMENT POWER PANEL	5020 A HIGH VOLTAGE SUPPLY (TIMING UNIT)	5023 A SYNC SWITCHING UNIT	5020 A HIGH VOLTAGE SUPPLY (TIMING UNIT)	5051 A BRIDGING AMPLIFIER	5039 A LINE AMPLIFIER	5039 A LINE AMPLIFIER	5008 A HIGH VOLTAGE SUPPLY (W.F. MONITOR)	5097 A PICTURE EQUIPMENT POWER PANEL
5050 A BIAS SUPPLY (SYNC. DIST. AMP #1.)	5015 A TIMING UNIT	5024 A SYNC DISTRIBUTION AMPLIFIER #1	5015 A TIMING UNIT	5056 A REMOTE SYNC PHASING UNIT	5051 A PICTURE DISTRIBUTION AMPLIFIER	5051 A PICTURE DISTRIBUTION AMPLIFIER	5009 B PICTURE MONITOR	5019 A LOW VOLTAGE SUPPLY (ON AIR BRIDG. AMP.)
5050 A BIAS SUPPLY (SYNC. DIST. AMP #2)	5018 A BLANKING UNIT	5025 A SYNC PATCH PANEL	5018 A BLANKING UNIT	5063 A PATCH PANEL	5054 A PATCH PANEL	5062 A PATCH PANEL	5010 B WAVE FORM MONITOR	5019 A LOW VOLTAGE SUPPLY (ON AIR PICT. MONITOR
5019 A LOW VOLTAGE SUPPLY (SYNC. DIST. AMP #1)	5017 A SHAPING UNIT	5024 A SYNC DISTRIBUTION AMPLIFIER #2	5017 A SHAPING UNIT	5057 A SYNC STRETCHING UNIT	5051 A BRIDGING AMPLIFIER	5051 A BRIDGING AMPLIFIER	5019 A LOW VOLTAGE SUPPLY (PICTURE MONITOR)	5019 A LOW VOLTAGE SUPPLY (PREVIEW BRIDG. AMP.)
5019 A LOW VOLTAGE SUPPLY (SYNC. DIST. AMP. #2)	5019 A LOW VOLTAGE SUPPLY	5055 A SWEEP AUXILIARY	5019 A LOW VOLTAGE SUPPLY	5057 A SYNC STRETCHING UNIT	5050 A BIAS SUPPLY (LINE AMP.)	5050 A BIAS SUPPLY (LINE AMP.)	5019 A LOW VOLTAGE SUPPLY (W. F. MONITOR)	5019 A LOW VOLTAGE SUPPLY (PREVIEW PICT. MONITOR
				5019 A LOW VOLTAGE SUPPLY BRIDGING AMPLIFIER	5019 A LOW VOLTAGE SUPPLY LINE AMP. & W.F. MONIT.	5019 A LOW VOLTAGE SUPPLY LINE AMP. & W.F. MONIT.		5008 A HIGH VOLTAGE SUPPLY ("ON AIR & PREVIEW" W.F. MONITORS.)
					5019 A LOW VOLTAGE SUPPLY (DISTRIB. AMP.)	5019 A LOW VOLTAGE SUPPLY (DISTRIB. AMP.)		

gram sources pass through Master Control it is only logical that it function as the central control point for all private line communication facilities used both at remote, network, and local studio points. A typical local studio-remote pickup program may require, for example, a three-way private line telephone facility between the local studio, the Master Control room, and the remote pickup in the field.

2. In connection with the Patch Panel video function, (cf B4 above) it is convenient to have a test waveform and picture monitor available in the Master Control assembly. If the input to the waveform and picture monitor appears on the video patch panel, it is a quick matter to check the picture content or the video waveform of any intermediate video point appearing on the patch panel. In this way trouble shooting of program sources is greatly expedited.
3. Since the bulk of the synchronizing and video distribution equipment is housed in Master Control, and programs from all sources are available at this point it is convenient to locate the base of operations for the maintenance crew for the television plant adjacent to the Master Control room. This facilitates conducting a continuous preventive maintenance program which is so important to uninterrupted program continuity.

It should be apparent from this brief list of functions that a properly integrated Master Control room for even a moderate sized television station can become an exceedingly complex array of equipment. Because many stations will start operations on a small scale and expand their facilities as the occasion demands, it is particularly important to make sure that Master Control equipment first installed will easily be adapted to expanded operations at a later date.

This fact coupled with the extreme difficulty of predicting what type of operations will receive greatest accent at various times requires that the moderately complicated and complex Master Control facilities be designed with an extreme range of flexibility. In order to arrive at an economical solution to these several requirements it has seemed proper to develop a number of "packaged" Master Control assemblies, scaled in size to fit the needs of the various types of television broadcasting stations.

In the discussion that follows no reference will be made to audio facilities since this subject has been adequately handled in audio broadcasting practice.

It of course is obvious that since television broadcasting operations eventually will become an extremely valuable advertising medium it is important that the engineer furnish the potential broadcaster with equipment which reflects the maximum in reliability and stability of operation. Only in this way may interruptions of paid programs be minimized. To be commercially feasible, the reliability of audio broadcasting practice must be engineered into this equipment.

In terms of equipment this will involve duplicates of complicated units such as synchronizing generators, so that a stand-by is always available in case of equipment failure. It is also desirable to construct such equipment in relay rack and cabinet assemblies which permit easy access to all wiring and circuits. In this way, rapid routine maintenance and checking is readily accomplished. Fig. 2 shows a sync generator and distribution unit typifying packaging of Master Control equipment.

The five packages of Master Control assemblies are listed in Table I, together with their intended use and basic equipment complement.

As is evident from this table, the various packages differ from one another chiefly by the increase in facilities available through the use of additional equipment. Consequently, by describing the use of both the simplest and most complex installations, as shown in Table I, the utility of the intermediate classifications will be apparent.

TABLE I

Five Packages of Master Control Assemblies

Item	DuMont Type No.	Intended Use	Basic Equipment Complement
1	TA132A	Small television broadcast station	One (1) RMA type synchronizing generator
2	TA132B	Small television broadcast station	Two (2) RMA Type synchronizing generators, and a rapid change-over switch
3	TA133A	Intermediate television broadcast station	Same as item 2 plus an On-the-Air line channel switching desk and associated video and synchronizing signal distribution facilities
4	TA133B	Intermediate television broadcast station	Same as item 3 plus a preview line channel switching desk and additional associated video distribution facilities, as well as a video waveform and picture test monitor rack
5	TA134A	Large television broadcast station	Same as item 4, plus a remote facilities rack for the servicing of larger numbers of remote and network programs

Master Control Assembly

The TA132A Master Control assembly is intended for the smallest television broadcasting stations and comprises merely one RMA type synchronizing generator. Such a station might have a studio and control setup such as is shown in Fig. 3. The Master Control room in this case may be the same or an adjoining room to that used for the control of the film chain. This is logical since the basic program material furnished by such a station consists largely of remote pickups and film telecasts.

It is assumed that a dual film camera chain is used, which in the case of the equipment manufactured by these laboratories contains a four-channel line switching amplifier. Master Control provides driving and blanking pulses for the

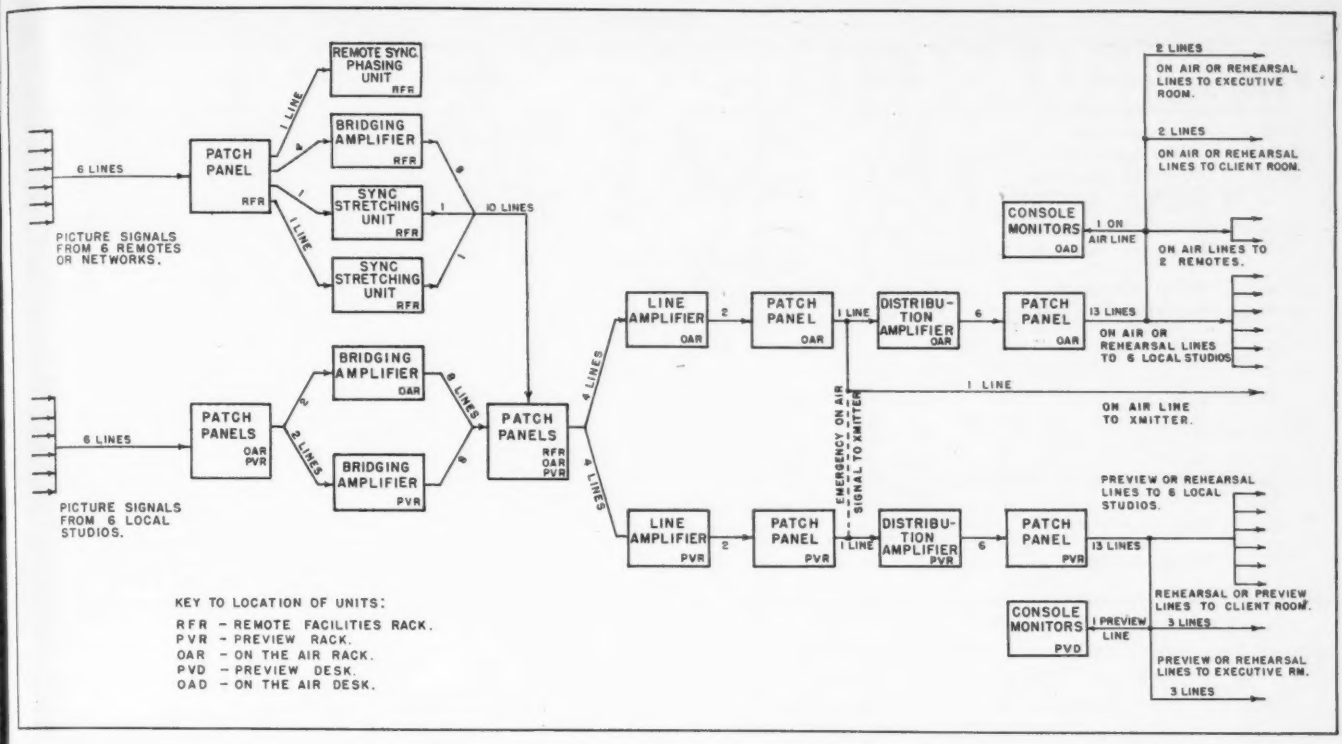

REMOTE SYNC PHASING UNIT RFR
BRIDGING AMPLIFIER RFR
SYNC STRETCHING UNIT RFR
SYNC STRETCHING UNIT RFR
6 LINES
PATCH PANEL RFR
PICTURE SIGNALS FROM 6 REMOTES OR NETWORKS.
1 LINE
10 LINES
BRIDGING AMPLIFIER OAR
BRIDGING AMPLIFIER PVR
6 LINES
PATCH PANELS OAR PVR
PICTURE SIGNALS FROM 6 LOCAL STUDIOS.
8 LINES
PATCH PANELS RFR OAR PVR
4 LINES
4 LINES
LINE AMPLIFIER OAR
PATCH PANEL OAR
DISTRIBU-TION AMPLIFIER OAR
PATCH PANEL OAR
CONSOLE MONITORS OAD
1 ON AIR LINE
2 LINES
ON AIR OR REHEARSAL LINES TO EXECUTIVE ROOM.
2 LINES
ON AIR OR REHEARSAL LINES TO CLIENT ROOM.
ON AIR LINES TO 2 REMOTES.
13 LINES
ON AIR OR REHEARSAL LINES TO 6 LOCAL STUDIOS
1 LINE
ON AIR LINE TO XMITTER.
EMERGENCY ON AIR SIGNAL TO XMITTER
LINE AMPLIFIER PVR
PATCH PANEL PVR
DISTRIBU-TION AMPLIFIER PVR
PATCH PANEL PVR
13 LINES
PREVIEW OR REHEARSAL LINES TO 6 LOCAL STUDIOS.
CONSOLE MONITORS PVD
1 PREVIEW LINE
3 LINES
REHEARSAL OR PREVIEW LINES TO CLIENT ROOM.
PREVIEW OR REHEARSAL LINES TO EXECUTIVE RM.
3 LINES
KEY TO LOCATION OF UNITS:
RFR - REMOTE FACILITIES RACK.
PVR - PREVIEW RACK.
OAR - ON THE AIR RACK.
PVD - PREVIEW DESK.
OAD - ON THE AIR DESK.

Fig. 5—Functional block diagram, involving twelve sources of program channels, arranged to permit signal to be followed

film chain, and the synchronizing pulses are mixed with the picture signal from the film camera in the line switching amplifier. Two extra channels are available for use in switching of remote programs or alternatively, one remote and one live talent studio output.

Such simple stations will probably use Image Orthicon field camera equipment for the remote program source, and if this equipment is brought into the live talent studio it can serve as a source of live talent programming, being considered as a remote facility by the switching amplifier associated with the dual film camera chain. The switching amplifier for the film chain should of course mix synchronizing pulses with picture signal only for film video and should not mix synchronizing information with the remote video when this source is being used.

In describing the more complex TA134A Master Control facility it will be most convenient to analyze it by hypothetically passing signals from the various sources to the final destinations. To gain a physical picture of what equipment is involved, this aspect will be briefly described first.

A total of nine racks of equipment plus two desks are involved. Two racks house two complete RMA type synchronizing generators and two additional racks provide power supplies, synchronizing signal distribution amplifiers and a patch panel for the distribution of synchronizing information to the various studios.

Control Desks

One of the desks will be called the On-The-Air desk and will have associated with it an On-The-Air rack containing an On-The-Air patch panel, power supplies, and picture distribution amplifiers. The other desk will be called the Preview desk, and will have facilities essentially duplicate to the On-The-Air assembly, available in a separate rack. The seventh rack will be called the Remote Facilities rack and will contain the remote facilities patch panel as well as sync stretchers and synchronizing phasing equipment.

An eighth rack will house the test video waveform monitor as well as the test picture monitor. The ninth rack contains power supplies for the video distribution equipment. A block diagram of this equipment is shown in Fig. 4.

The equipment as pictured is sufficient to handle as many as six local studio and six remote or network programs, providing suitable outputs to the transmitter, outgoing network programs, On-The-Air, Preview and rehearsal feeds to client rooms, executive offices, and return feeds to all studios. Each studio is arranged to have three video coaxial lines between the studio and the Master Control room. One coaxial line is used to provide the selected camera output to Master Control, and the other two coaxial lines are used to provide return feeds from Master Control of both the On-The-Air program as well as a rehearsal or Preview program.

In this way the director of a television show can monitor the picture which is sent to Master Control for broadcast purposes, as well as the return feed of this program showing basically the same signal as is sent to the transmitter. Also, for cueing purposes, the other return feed can show the program director the next program to be selected, in cases where program continuity calls for the outputs of two studios to be used in conjunction with one another. A plant facility of this size also has several client rooms where On-The-Air or rehearsal programs may be shown to representatives of the advertisers supporting the programs. In addition, provision is made for the feeding of desired sig-

TABLE II

TIME	PROGRAM	SOURCE	FEED
10:00 AM	Station identification	Film studio	Local transmitter
10:01	News commentator	Studio B	Local transmitter
10:15	Station identification	Film studio	Local transmitter
10:16	Presidential Inauguration Preliminary Shots from White House	Remote No. 1	Local transmitter and network
10:30	Station identification	Film studio	Local transmitter
10:31	Presidential Inauguration Shots from Penna. Ave.	Remote No. 2	Local transmitter and network
10:45	Station identification	Film studio	Local transmitter
10:46	Presidential Inauguration Ceremonies from Capitol steps	Remote No. 3	Local transmitter and network
11:31	"World Peace, Significance of Inaugural" Highlight Comment from U.N. New York	Network	Local transmitter
12:00 PM	Station identification	Film studio	Local transmitter
12:01 to 4:00 PM	Test pattern	Film studio	Local transmitter
4:00 PM	Sign-off	Film studio	Local transmitter
7:00 PM	Station identification	Film studio	Local transmitter
7:01	Film	Film studio	Local transmitter
7:01	New show rehearsal	Studios E and F	Client room A
8:00	Station identification	Film studio	Local transmitter
8:01	Film, continued	Film studio	Local transmitter
8:30	Station identification	Film studio	Local transmitter
8:30 to 8:31	Commercial	Film studio	Local transmitter
8:31	Quiz Show	Studio A	Local transmitter
8:31	New Show rehearsal	Film studio and Studio E	Client room B
9:00	Station identification	Film studio	Local transmitter
9:00 to 9:01	Commercial	Film studio	Local transmitter
9:01	Dramatic play	Studio B	Local transmitter and network
9:22	Film sequence, dramatic play	Film studio	Local transmitter and network
9:31	Dramatic Play	Studio B	Local transmitter and network
10:00	Station identification	Film studio	Local transmitter
10:00 to 10:01	Commercial	Film studio	Local transmitter
10:01	Variety show	Studio D	Local transmitter and network
10:30	Station identification	Film studio	Local transmitter
10:30 to 10:31	Commercial	Film studio	Local transmitter
10:31	Sign-off	Film studio	Local transmitter

nals to the executive offices which serve as additional client room facilities.

In Fig. 5 a functional block diagram is shown which will enable the picture signal to be followed through the various components of equipment. It will be instructive to trace the signals through this block diagram, showing the various units involved.

Twelve sources of program channels are available, six from local studios and six from remote or network programs. These signals appear on the patch panels associated with the On-The-Air rack and the Remote Facilities rack shown in Fig. 6. The studio outputs are labeled A through F on the OAR patch panel and the remote program sources are labeled 1 through 6 on the RFR patch panel. For convenience the studio signals will be traced first.

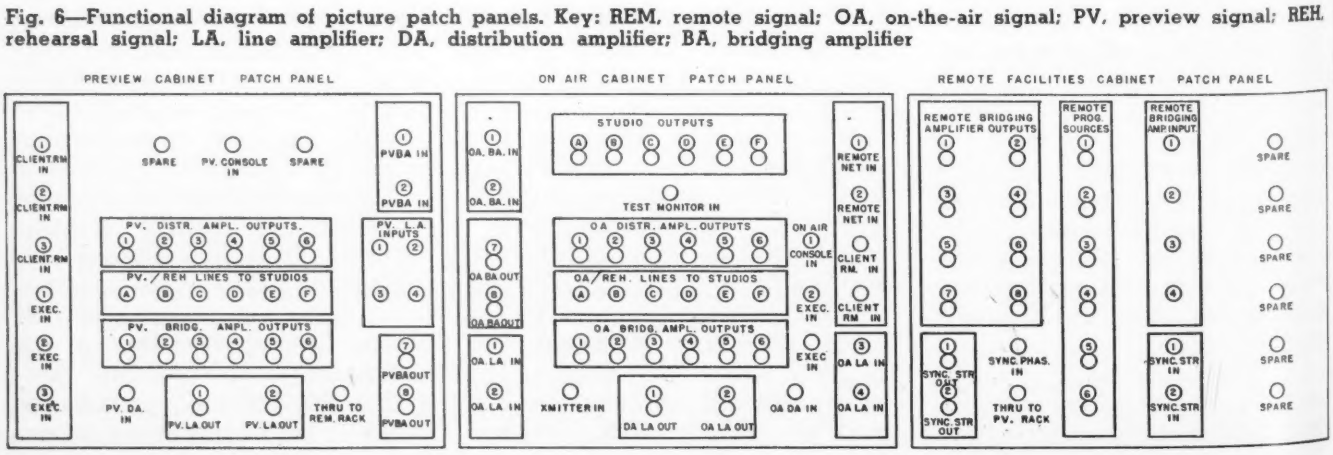
Of the six studios, four are selected for immediate use. Two of these go to the bridging amplifier in the OA rack and two to the bridging amplifier in the PV rack. A bridging amplifier basically provides two inputs and four multiple outputs for each input. Having passed through the bridging amplifier, there now exist four lines for each of four selected video channels. These outputs also appear on the OAR patch panel and the PVR patch panel, where they are labeled OA bridging amplifier outputs and Preview bridging amplifier outputs, the total consisting of 16 lines. One four-channel line amplifier is situated in the On-The-Air rack and another in the Preview rack.

These amplifiers are controlled by four-section push-button switches situated in the On-The-Air and Preview desks respectively. Consequently, if no remote programs are desired, four signal lines, two from each bridging amplifier, are patched through to the line amplifier in the On-The-Air rack and the line amplifier in the Preview rack. The output of the On-The-Air line amplifier consists of two multiple lines each showing the selected one of the four input channels.

These two outputs again appear on the OAR patch panel, one normally being permanently tied to the transmitter input the other going to a studio distribution amplifier. The studio distribution amplifier is identical to the bridging amplifier except that its inputs and outputs are multiplied in a different manner. It is arranged to have but one input line and six output lines. Each of these six output lines again appear on the OAR patch panel and they now represent the On-The-Air program. One output is returned to the On-The-Air desk where it is displayed on the console monitor, and another is returned to the selected studio

(Continued on page 142)

Fig. 6—Functional diagram of picture patch panels. Key: REM, remote signal; OA, on-the-air signal; PV, preview signal; REH, rehearsal signal; LA, line amplifier; DA, distribution amplifier; BA, bridging amplifier



IRE Winter Meeting

Four-day gathering and exhibition to draw record attendance

New home of Institute of Radio Engineers located at 1 East 79th Street, New York

Technical Program Schedule for IRE Winter Convention

	HOTEL COMMODORE			GRAND CENTRAL PALACE	
	East Ballroom	Main Ballroom	West Ballroom	Auditorium I	Auditorium II
MONDAY (Mar. 3)					
2:00 P.M.- 5:00 P.M.	.....	Particle Accelerators for Nuclear Studies	Electronic Measuring Equipment	Radar & Communication Systems	FM Reception
TUESDAY (Mar. 4)					
10:00 A.M.-12:30 P.M.	Aids to Navigation	.....	Nucleonics Instrumentation	Microwave Compon'ts & Test Equipment	Television A
2:30 P.M.- 5:00 P.M.	Television B	.....	Electronic Digital Computers	Power Output Vacuum Tubes	Circuit Theory
WEDNESDAY (Mar. 5)					
10:00 A.M.-12:30 P.M.	Electronic Controls & Applications	Aids to Air Navigation & Traffic Control	.....	Microwave Technics & Measurements	Broadcasting & Recording
2:30 P.M.- 5:00 P.M.	.....	On the Profess'l Status of the Engineer	.....	.....	.....
THURSDAY (Mar. 6)					
10:00 A.M.-12:30 P.M.	Oscillator Circuit Theory	.....	Basic Electronics Research	Wave Propagation & Antennas	Relay & Pulse-Time Communica. Sys.
2:30 P.M.- 5:00 P.M.	Receiver Circuits	.....	Vacuum Tubes & Gas Rectifiers	Antennas	Wave Guide Technics

• The Institute of Radio Engineers is all set for its largest gathering—the 1947 Winter Convention, scheduled for the four days starting Monday, March 3, and winding up the following Thursday. It is expected that registration will exceed last year's attendance of something over 7000, when there were 2200 at the organization's thirty-fourth anniversary banquet.

Most of the technical sessions are to be held in the commodious rooms of the Hotel Commodore. Several are to be held in auditoriums in Grand Central Palace where the largest exhibition of radio and electronic parts, components, instruments and equipment will be staged concurrently.

The technical program is a long one. Spread over the four days there are to be more than 125 engineering papers covering every phase of radio communications in all fields and electronic applications in industrial fields. The wide scope of the program is indicated by the condensed schedule on this page. The complete program, together with the list of exhibitors at Grand Central Palace, appeared on pages 54 and 55 of *Tele-Tech* for February.

Grand Central Palace, which will house the IRE Exhibit, and which is also the headquarters for Tele-Tech and Electronic Industries and Instrumentation where the latch-string is always hanging out. Address is 480 Lexington Ave.

Oscillator Tracking Methods in Permeability Tuning

By HARRY E. FAIRMAN

Practical advantages of the system, and a consideration of design problems involved in electrical and mechanical arrangement of parts

• The transition from capacitor-tuned superheterodyne receivers to permeability-tuned ones need not be a source of design difficulties, for the mathematical tools devised for the solution of oscillator tracking problems[1,2] in capacitively tuned superheterodynes can be of considerable use in the design of permeability tuning systems for the same use.

A clear mental picture of the permeability-tuned system may be had by reversing the rôles allotted to L and C in the capacitively-tuned system.[3] Thus the familiar series-padded oscillator circuit (Fig. 1) becomes the analogous permeability-tuned circuit (Fig. 2). The fixed inductance that determined the midband tracking point in the circuit of Fig. 1 becomes a fixed capacitance in Fig. 2, and the capacitive padder becomes an inductive one. There is no particular point, however, in using an inductance for high-end trimming.

From the historical point of view, permeability tuning[4] might be said to be in a state of development similar to that of capacitive tuning in 1930. It will be recalled that early single-dial superheterodyne designs used capacitor gangs made to wide tolerances—in fact, units intended for use in tuned-radio-frequency receivers—and front-end designs in those days were largely a matter of cut-and-try. Mathematical analysis of the problem and improved designs of coils and variable capacitors reduced the tracking error to a tolerable value within a few years. Capacitor gangs with shaped oscillator sections, the cut-plate gangs, which obviated the need for padding capacitors, were also introduced but the results obtainable with them were not regarded as in the same order of excellence with those obtained with padders.

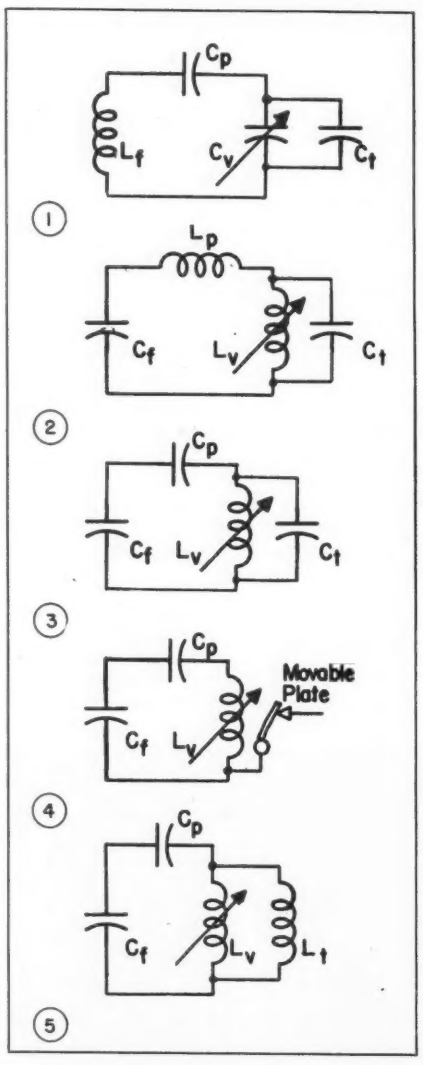


Fig. 1—Commonly used capacitance-tuned series-padded oscillator circuit. In these figures subscripts (f) (v) (p) and (t) refer to fixed, variable, padding and trimming elements respectively. Fig. 2—Analogous permeability-tuned version. Fig. 3—Capacitor replacing inductive padding. Fig. 4—A substitute for the trimmer. Fig. 5—Permeability tuned inductance here is provided with shunt inductance for trimming

It has been shown by Roder[1] that circuit configurations more complex than the series-padded arrangement of Figs. 1 and 2 do not provide better tracking unless additional tuning elements are added. Since tracking errors of the order of three kc or less are obtainable in the broadcast band and comparable results are possible at higher frequencies, the added complexity of two or more variable elements in the oscillator circuit cannot be justified by the resultant improvement in tracking. Graphical and arithmetical methods for the design of series-padded circuits are described in the literature.[5]

Midband Tracking

Midband tracking in series-padded circuits is obtained by the choice of an appropriate value of inductance, the fixed element, in capacitance-tuned systems. In practice, minor changes are made in this value during manufacture, but further adjustments are seldom—if ever—made during the life of the receiver. Minor variations in the constants of the coil caused by aging or thermal cycling can be compensated for in the normal alignment procedures.

In permeability-tuned systems the analogous capacitor can be either specified in close tolerances or adjusted and sealed-off during

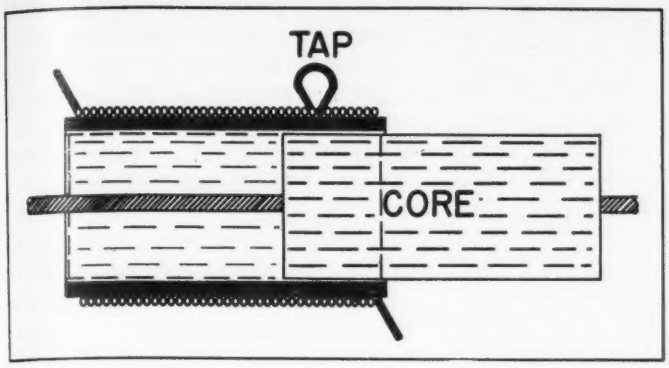


Fig. 6—Cross-section of an oscillator coil tapped for feedback. Moving core away from the center of the winding reduces feedback

manufacture. Since subsequent readjustments of the value of this capacitor would unnecessarily complicate servicing alignment procedures, no provision need be made for readjustment. The close-tolerance fixed capacitor would seem to be the best choice for this circuit position.

Padding Capacitance

Low-end tracking is controlled by the series padding capacitor in capacitance-tuned systems. It is customary to provide a range of adjustment of about ±15%, centering at the nominal value for broadcast frequencies. At higher frequencies a fixed capacitor is often used for this purpose. The padder, if variable, is adjusted during the original alignment of the receiver and is usually accessible for servicing realignment.

In permeability-tuned systems the analogous component may be either an inductance or a capacitance. If a padding capacitance is used it would occupy the customary position in series with the fixed capacitor and the variable inductor, but a padding inductance might either occupy the same position or shunt the variable inductance. Any one of the three padding methods might be used in a given design, for all are of equal utility in permeability-tuned systems.

High-end tracking is controlled by the shunt trimmer capacitor, usually gang-mounted in single-band receivers, in capacitance-tuned systems. The trimmer, like the padder, is adjusted during the original alignment and is accessible for realignment. In permeability-tuned systems no useful purpose is served by changing its identity, so it usually remains a capacitor. The function of the trimmer can be adequately fulfilled by a re-orientation of coil and core, which may be accomplished by a number of mechanical methods, such as moving the coil in chassis slots or screwing the core on a threaded rod. It is interesting to note that coil or core movement may also serve as a padding adjustment if a trimmer is provided. In either case, with the padder or trimmer omitted, considerable interaction between the remaining adjustments, i.e., either trimmer or padder and coil movement, will be experienced.

For the general case of a padded oscillator, the best performance in

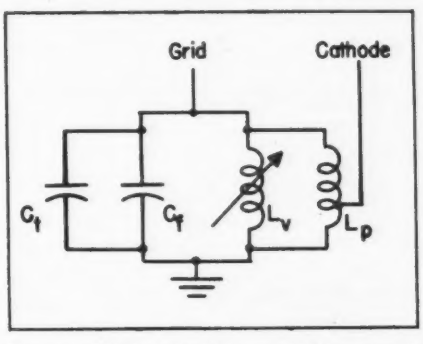


Fig. 7—"Hot-cathode" oscillator circuit

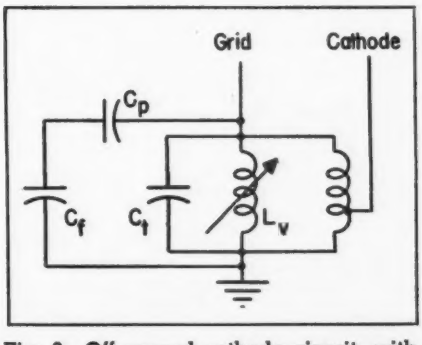


Fig. 8—Off-ground cathode circuit, with tapped feedback coil for mid-band adjustment with permeability tuning

so far as tracking is concerned seems to be obtained when the trimmer condenser is retained and the coil inductance adjusted during the manufacture of the receiver in capacitance-tuned systems. In permeability-tuned systems the same adjustments can be provided at a smaller cost in material and labor.

Non-padded permeability-tuned circuits, which possess certain advantages over their capacitance-tuned counterparts, will be discussed in a later section of this article.

The following circuits will be discussed from the viewpoint of the oscillator tuned circuit only, except in the case of the "hot-cathode" circuits used with pentagrid converters such as the 6SA7. The feedback method used when separate oscillator tubes or pentagrid converters with an oscillator plate connection (6A7 or 6A8, for example) are used has little bearing on a discussion of tracking problems and methods.

As stated earlier, the reversal of a capacitance-tuned series-padded circuit (Fig. 1) into its permeability-tuned counterpart is shown in Fig. 2. This circuit, which sedulously replaces L with C and C with L (except for C_t, which is retained for practical reasons), would probably be more costly than a circuit that used a capacitor for padding and has no practical advantage over it.

Tracking Alignment

The capacitance-padded version, shown in Fig. 3, is a workable arrangement; and if C_t is adjusted for optimum value during the initial alignment of the receiver very good tracking can be obtained. This circuit, with its three "degrees of freedom",[1] is very well adapted to mass production. Coils and capacitors do not need to be segregated into matched sets, for the variations due to random selection can be compensated for in the initial alignment.

The circuit of Fig. 3 can be simplified by the omission of C_t, using instead a mechanical adjustment that changes the relative positions of coil and core. This was done in prewar tuning kits that had a considerable sale, and it worked quite well. An adjustment of this type has also been incorporated in a recent General Electric table model receiver[6] (a tuned-radio-frequency receiver rather than a superheterodyne). If the front-end components of a receiver using mechanical adjustments for trimming are closely matched the tracking will be good,

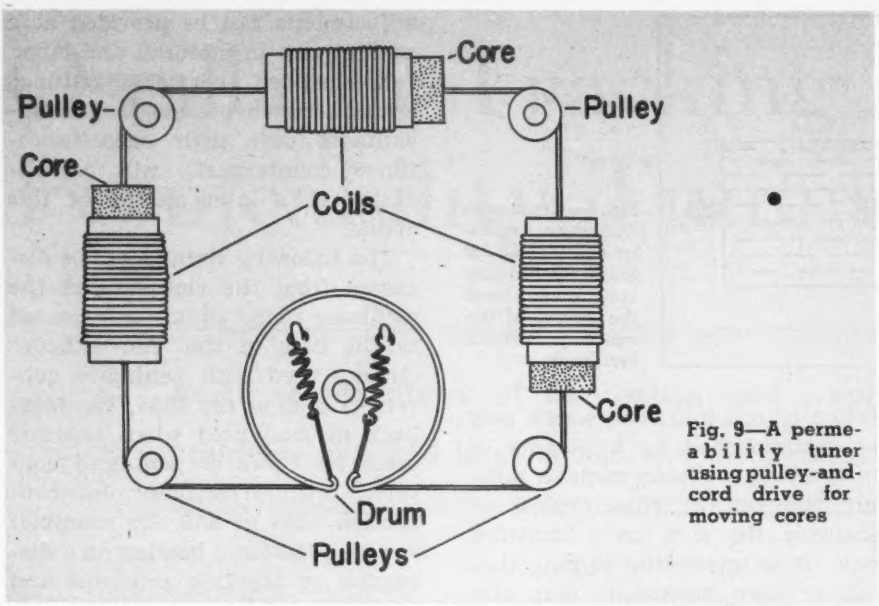


Fig. 9—A permeability tuner using pulley-and-cord drive for moving cores

but if parts within the tolerance limits are selected at random the tracking deviation will be considerable.

The circuit of Fig. 3 can also be used with a fixed capacitance at C_p, using coil movement for padding purposes. The trimmer C_t would be used in this case, providing the high-end adjustment. A considerable amount of interaction between the high- and low-end adjustments would result from this simplification, but the arrangement is usable.

Another variation, suitable for use in low-cost receivers, is shown in Fig. 4. Here a movable plate that adds to the distributed capacitance of the coil replaces the trimmer C_t. The range of adjustment that can be attained by this means is limited as compared with that attained with a trimmer and the Q of the coil would be reduced.

An inductive trimmer (as mentioned by Terman[3]), shown in Fig. 5, would be, in all probability, more costly than a capacitor that would serve the same purpose. The inductive trimmer, however, might be of use in designs where capacitance trimmers were contraindicated for any reason.

The use of pentagrid converter tubes without a separately usable anode-grid, such as the 6SA7, requires a rearrangement of the oscillator circuit to obtain a direct-current path and the required feedback connection. Capacitance-tuned circuits for the 6SA7 customarily tap the fixed oscillator coil for feedback and connect the cathode of the tube to the tap, thus providing a direct-current path as well.

A tapped coil is not desirable in a permeability-tuned system where it is the variable element, however, for two reasons. Firstly, the percentage of feedback would vary in accord with the core position, as illustrated in Fig. 6; and (2), the tuning curve for the coil would have a discontinuity or bump centering at the tap.

A circuit for a hot-cathode oscillator with permeability tuning is shown in Fig. 7, where the shunt inductor L_p serves the dual purpose of a padder and a source of a fixed amount of feedback.[7] If the coil is proportioned so as to permit the required range of padding adjustment with a relatively small core movement that does not approach the tap location, the percentage of feedback will then remain substantially constant. It should be noted that the padder in this circuit is more truly a mid-band adjustment rather than a low-end one; but satisfactory results are obtained from its use as a padder, nonetheless.

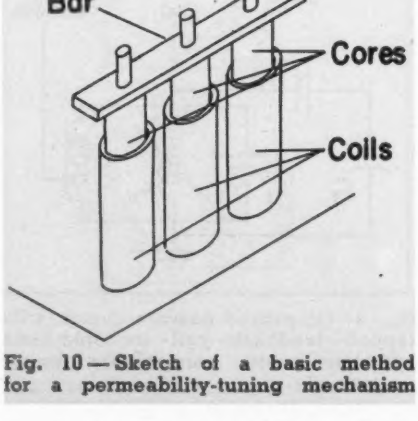


Fig. 10—Sketch of a basic method for a permeability-tuning mechanism

The addition of a padder to this circuit, shown in Fig. 8, uses a tapped feedback inductor as the mid-band adjustment rather than as the padder. This circuit is the off-ground cathode version of Fig. 3, and is characterized by a minimum amount of interaction between its high- and low-end adjustments, too.

Most of the permeability tuning mechanisms thus far produced have used pulley-and-cord arrangements for actuating the tuning cores. A typical arrangement of this sort is shown in Fig. 9. The tension springs are needed to take up any stretching of the cords, and the dial-pointer should also be adjustable so that correct dial settings may be made. The stretching of the cords incident to age and use unfortunately is not always equal in all four lengths, and electrical realignment cannot always compensate for this.

Tuning Drives

The arrangement shown, where the two springs terminate the end cords at the drum, or alternative arrangements in which a single spring terminates both cords or stresses a continuous length of cord, are preferable to arrangements that interpose springs between adjacent cores. Nylon-jacketed cord or woven metallic cable are the most suitable materials for the stringing of pulley-and-cord systems because of their lack of stretch.

In pulley-and-cord drives considerable attention should be given to the method employed for fastening the cords to the cores and the springs. Cemented knots, metal clips, or metal beads (as used in bead-chain) are suitable for fastening methods. Methods that do not permit fairly precise adjustments of cord length or ones that are liable to slippage should be avoided. When cemented knots are used, design allowance should be made for longitudinal coil movements (about $\pm\frac{1}{8}$ in.) to provide for an initial mechanical alignment of coils and cores after assembly.

An attractive method that does not use cords between adjacent cores, has the cores mounted at intervals along a rod that is actuated by cords or any other convenient means. Its disadvantage is that the coils must likewise be arranged in a line and sufficient shielding or spacing, or both, makes the tuning unit prohibitively long or mechanically complex.

Mechanical Stability

In a more feasible method, Fig. 10, a bar mounts the cores in a horizontal row, positioned at each coil. The coils are enclosed in shields that are not shown in the figure. This method, although probably more costly than the pulley-and-cord drive, is desirable from the viewpoint of mechanical stability. If screw-mounted cores are used with a threaded mounting bar and lock-nuts, precise core adjustments can be made. A possible variation on this method would be to arrange the cores and coils at the points of an equilateral triangle.

Permeability tuning mechanisms of the type described in the preceding paragraph could be constructed from stamped metal forms, since some amount of guiding action is obtained from the closeness of fit between the tuning core and the coil form.

The padding capacitor can be omitted in capacitance-tuned systems if the oscillator section of the capacitor gang has specially shaped plates. Other methods have been proposed, but they have not been used to any extent in commercially built receivers. For the same amount of tracking error, a non-padded oscillator requires closer tolerances in the capacitor gang and coils than the padded oscillator, for the "knifing-in" that is possible with the slit end-plates of each section does not approach the range of adjustment possible with padded oscillators.

Non-padded permeability-tuned systems offer a greater possibility of good tracking than capacitively-tuned ones, for the factors that control tracking are relatively more easily tested and controlled, and can be expected to be more stable over long periods. The factors are: (1) coil inductance, (2) core permeability, and (3) core dimensions. All three of the factors can be readily measured prior to assembly and subsequent handling and assembly of the components will cause little or no change in the measured values.

It is well known that capacitor gangs can be carefully tested and knifed for desired values of capacitance at a number of angular positions, only to have assembly operations distort the frame and necessitate a repetition of the same adjustments on the mounted gang. Permeability tuning components are relatively more stable and rugged, and except for core chipping—which can be seen by the assembler — and coil-form distortion due to improper mounting, there is little chance of the common front-end troubles that occur in capacitance-tuned receivers.

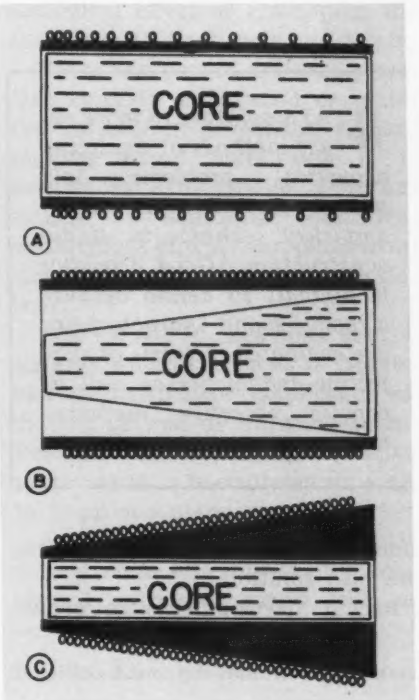


Fig. 11—Coil designs for non-padded oscillators. (A) Variable-pitch winding, (B) tapered core and (C) tapered form

One coil design for a non-padded oscillator is shown in Fig. 11. The coil is wound on a form of constant diameter with a variable pitch, and the tuning core is of constant diameter. This design can use standard cores and the coil form might be grooved or threaded to receive the turns of wire. Alternatively, the coil form could have a smooth outer surface provided the winding machine was altered to provide a non-constant rate of progression for the coil form.

In Fig. 11 (B) the core is tapered and a constant diameter, constant pitch coil is used. In this design the coil could be produced more readily than the one previously described, but the core is special.

A somewhat tentative design, in Fig. 11 (C) has a tapered coil of constant pitch wound on an externally tapered form and a constant diameter coil is used. This type of coil could be produced on the usual winding machines, but in broadcast band the desired inductance range would be difficult to obtain.

Several other interesting coil designs can be obtained by combining portions of the constructions in Fig. 11. For example, assuming the use of a constant diameter core, a coil of variable pitch might be wound on the tapered coil form. Another possibility is the winding of Fig. 11 (A) and the core shape of (B). Further design flexibility would be obtained by using coil forms with non-linear rates of taper or stepped forms.

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2. R. De Cola, A Superheterodyne Tracking Solution, "Electronics," February 1942, 15, 2, p. 29.
3. F. E. Terman, Radio Engineers' Handbook, 1st ed., 1943, pp. 649-652.
4. A bibliography of articles and papers on permeability tuning, "Electronics," February 1942, 15, 2, p. 95.
5. F. L. Smith, Radiotron Designer's Handbook, 3rd ed. (4th imp.), 1941, footnote on p. 110.
6. (General Electric Model 50), see "Radio & Television Retailing, October 1946.
7. (Used in the Motorola 705 auto-radio receiver), see cover circuit, "Service," September 1946.

Radio Transmission of Fingerprints

This is the title of a report by Supt. I. R. Churchill, Pp. 12, Commissioner of the Police of the Metropolis, New Scotland Yard, London, S.W.1. Successful tests on the transmission of fingerprints on radio waves have been carried out between Great Britain and Australia during the last year.

Philips Review, Index

Philips Laboratories have let it be known that an index is available listing all articles that appeared in *Philips Technical Review* during the period of January 1936 to June 1942. The index may be obtained free from Elsevier Book Co., Inc., 215 Fourth Ave., New York 3, N. Y.

Acoustical Design of Broadcast Studios

By JOEL PETERSON
Assistant Editor, Tele-Tech

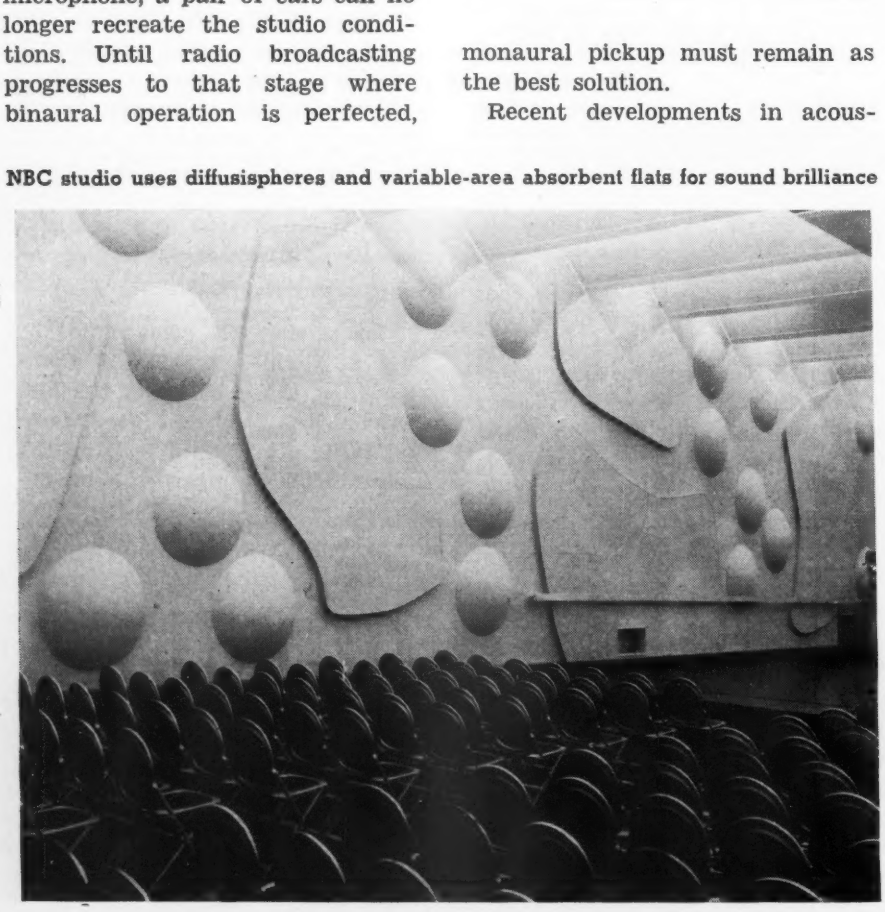
Modern surface treatments that eliminate wallowing, echoes and other objectional features and give brightness and liveness to the studio

WAYS pointing to more exact methods of analyzing acoustical problems hold promise for the elimination of empirical technics in studio construction. Good acoustics is difficult to define because a room's sound characteristics are evaluated in terms of subjective judgments as well as concise objective measurements.

• Monaural acoustic perspective and binaural acoustic perspective are the terms used to differentiate between microphone pickup and human hearing and are of sufficient importance to warrant further investigation. The microphone alone does not have the binaural perspective capacity to discriminate against unwanted sound and thus cannot record the spatial effect of the room characteristics as does the human binaural mechanism. Once the sound is translated by the microphone, a pair of ears can no longer recreate the studio conditions. Until radio broadcasting progresses to that stage where binaural operation is perfected, monaural pickup must remain as the best solution.

Recent developments in acoustical treatment of broadcast and recording studios have shown a design trend variously known as diffusive design, dispersive treatment, polycylindrical, globular or quasi-elliptical surface treatment. As most engineers know, the common objective of these convex surfaces is not to reduce reflections, but to scatter them in such a way as to eliminate undersirable sound effects such as "hollofing," "wallowing," "echoes" and other objectionable characteristics due to interference patterns set up within the confined space. Complete elimination of reflection, once sought in the design of "dead" broadcast studios, is recognized to be erroneous because it detracts from the "brightness" or "liveness" of the room.

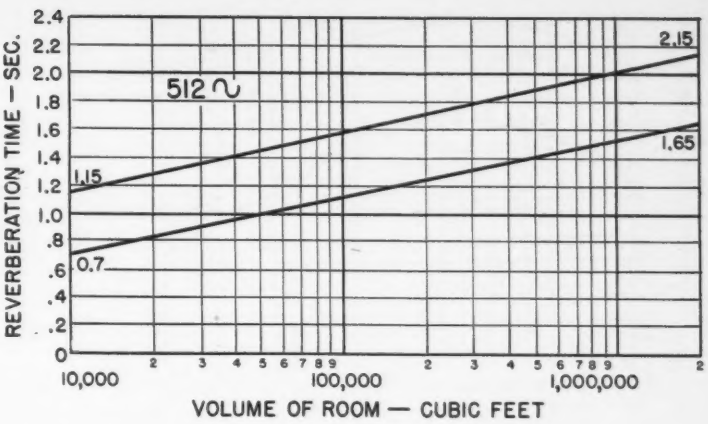
NBC studio uses diffusispheres and variable-area absorbent flats for sound brilliance



Measurements have shown that curved surfaces produce much less interference because the intensity of sound along any one direction is less than for reflections from flat surfaces. One practical example of the reduction in interference in rooms treated with convex surfaces compared with rooms with conventional flat surfaces is indicated in the results of measurements taken in a modern recording studio. In a room with flat surfaces, the interference caused variations in sound level of about 18 db. In the studio using diffusive design, the average reduction in reflection interference patterns was approximately 7 db, an improvement of almost 40 per cent.

The Acoustical Materials Association has prepared a graph of the permissible reverberation time lim-

its for rooms of different volumes. For broadcast audience studios equipped with sound reinforcement, the reverberation time should fall near the lower limit to preclude acoustical feedback. Until a short time ago, the acoustical construction of a broadcast studio merely emphasized reverberation time, the time required for sound to diminish 60 db from its original value. As the art progressed, the significance of the period-frequency characteristic became well recognized. Now the distribution of aftersounds and other unmeasurable subjective effects, which do not satisfy an electrical measuring instrument so much as they do the listener, must be accounted for if the studio is to have sound "brightness."



Acoustical Materials Association chart illustrating permissible reverberation-time limits in rooms of various volumes

Sound Distribution

Measurements in rooms known for their good acoustics have shown that such rooms have ideal sound diffusion, which is probably the important factor contributing to their acoustical excellence. Diffuse sound distribution is obtained by use of various types of convex or splayed reflecting surfaces. The important point regarding sound diffusion is that it increases the number of reflections for a given period of time, sustaining the total sound energy level, and lessens the energy level of the individual reflections. Convex surfaces produce a smoother sound decay curve, and the studio can tolerate a higher reverberation time. This allows a better compromise between the optimum condition for speech and the optimum condition for music. The placement of microphones becomes less a matter of skill since the increased number of reflections at reduced energy levels serves to free the studio of resonant areas.

Diffusers create a sound energy distribution within the studio that provides a listening ear with sound coming from many random directions and from a greater number of small sound sources. This effect is more important from the subjective point of view since the binaural characteristic of a pair of ears provides a more acute perception of the combination of tone, loudness and direction, a feat which no measuring device can record simultaneously. These intangibles, nevertheless, produce the important psychological effect of enveloping the audience and creating tonal "depth".

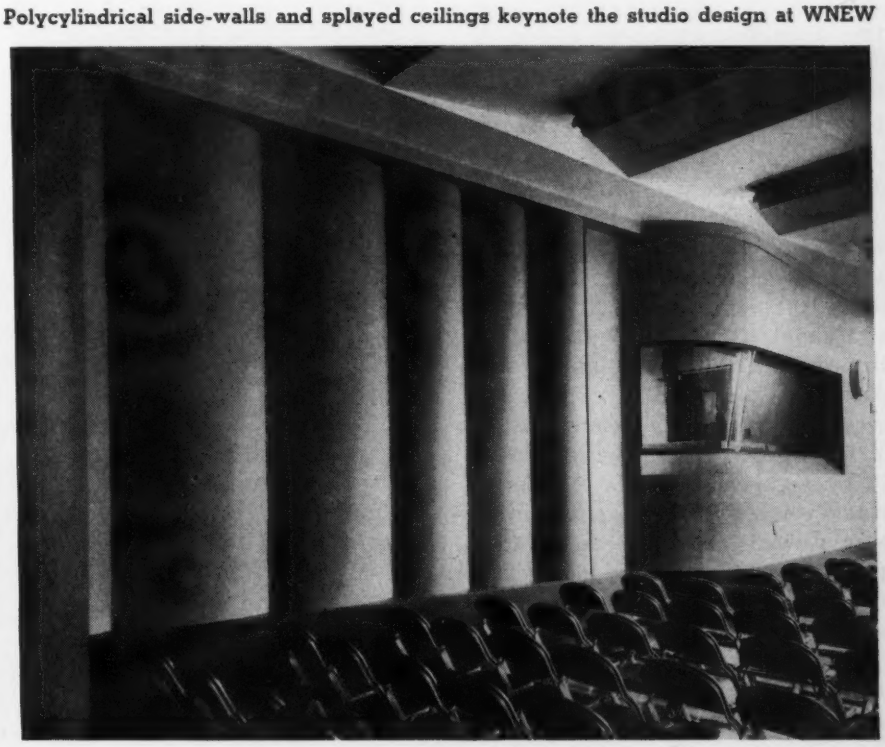
When the curved reflecting surface consists of plywood or material of similar properties, an impinging sound wave sets it in motion as sympathetic vibration, causing an additional (desirable) scattering effect, supplementing that given by normal reflection laws.

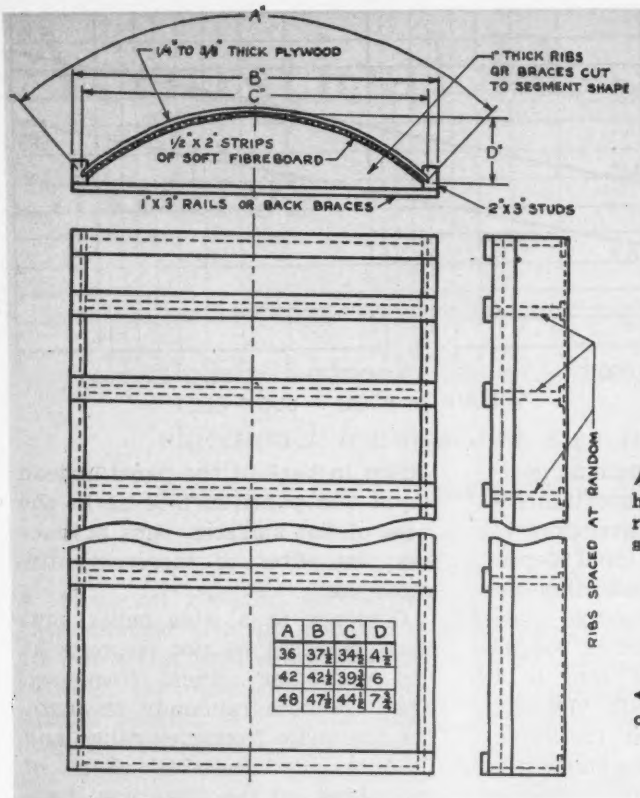
The curved surface also acts as an area sound source as it vibrates like a loudspeaker diaphragm radiating as well as diffusing sound. Further, an impinging spherical sound wave is re-radiated as a cylindrical or a plane wave.

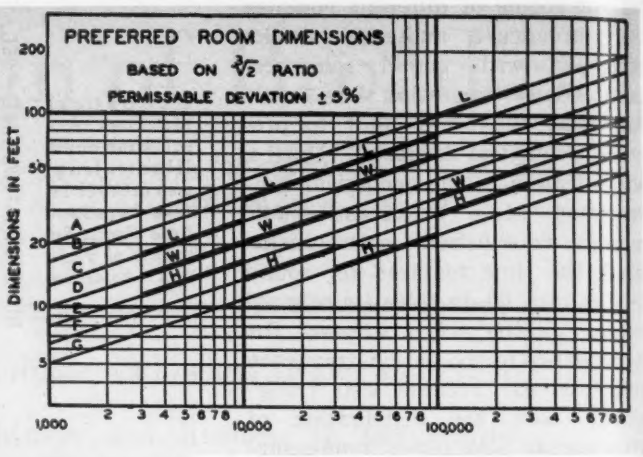
Another important aspect of the curved surface is that it provides a virtual source of sound with an origin in back of the panel instead of at the panel surface as in the case of flat surfaces, thus producing the effect of increasing the room size.

Contrary to a wide belief, plywood surfaces do not resonate at one particular critical frequency. They resonate randomly throughout the audio frequency range and produce the desirable effect of smoothing out the frequency characteristic. The air chamber behind the cylindrical surface, however, has shown a tendency to resonate at one critical frequency. The vibration of the panel is desirable, but the vibration of the air chamber behind the wood panels is not, especially at low frequencies. This can be eliminated by lining the chamber with absorbent material, taking care that no absorbent

Polycylindrical side-walls and splayed ceilings keynote the studio design at WNEW




A"
1/4" TO 3/8" THICK PLYWOOD
B"
C"
1" THICK RIBS OR BRACES CUT TO SEGMENT SHAPE
1/2" X 2" STRIPS OF SOFT FIBREBOARD
D"
1" X 3" RAILS OR BACK BRACES
2" X 3" STUDS
RIBS SPACED AT RANDOM
A B C D
36 37 1/2 34 1/2 4 1/2
42 42 1/2 39 1/4 6
48 47 1/2 44 1/2 7 3/4



Length, width and height dimensions for rooms of various shapes and volumes

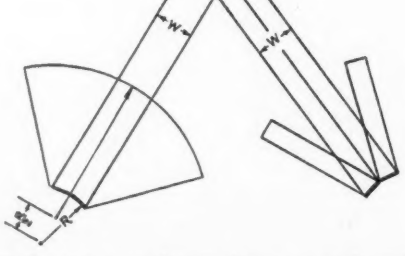
Construction details of a curved surface

comes in contact with the plywood surface. In order to eliminate selective absorption at any frequency, particularly at the low end of the audio range, it is desirable to vary the transverse dimensions and the radii of the cylindrical surfaces. Further, the surfaces should be curved over a support consisting of ribs spaced at random to reduce specific resonances as indicated by Volkmann.

Volkmann has also determined the dispersive effect of a convex surface compared with a flat surface. Rettinger makes the comparison with splayed flat surfaces.

A typical studio built around the dispersive principle obtains maximum diffusion in the three planes when the polycylindrical surfaces are arranged with their axes mutually perpendicular. To obtain additional diffuse sound dispersion, three different sized panels and curvatures are used. The high degree of diffusion is demonstrated in the smooth sound decay curves. The reverberation times of such a studio remain within narrow limits over a wide range of audio frequencies; 0.65 second at 100 cycles, 0.47 second at 1,000 cycles, and 0.62 second at 8,000 cycles.

The Johns-Manville acoustical laboratory has prepared data on three treatments manufactured for broadcast studio sound control. The three types of treatments developed are referred to as high frequency, low frequency and triple-tuned elements. The absorbing power of these elements at various frequencies is shown in Table I. Treatment of studios with materials having high, low or uniform absorption characteristics enables the acoustical engineer to control the shape of the reverberation time-frequency characteristic — an important factor in obtaining the desired acoustical characteristics for speech, music or combination studios.



Reflected wavefronts from curved and splayed plywood surfaces of equal width

For example, the pitch range for male voices is from 82 to 466 vibrations; for piano, 27 to 4186 vibrations. This marked difference is evidence of the need for designing studios for speech as well as for music. The range of female voices, 196 to 1046 vibrations, suggests that meticulous design in the future may feature studios for female commentators as well as for male commentators.

The application of frequency responsive sound elements is important from another viewpoint. The pitch of musical instruments is rich in overtones, this being the criterion for distinguishing two unlike musical instruments struck in the same key. The high energy level in the harmonics of the fundamental tone must be preserved, and can only be retained when the sound absorbent is chosen in accordance with good acoustical judgment.

Studio Proportions

Heretofore, the height, width and length dimensions of a broadcast studio were sometimes calculated in the proportion 2:3:5. The most recent practice, however, is to increase the dimensions progressively in multiples of ⅓ of an octave. This is called the cube root-of-two rule. For example, if we begin with a ceiling height of 18 ft. for an average shape room, frequent practice in the broadcast field was to make the dimensions 18 ft. high, 27 ft. wide and 45 ft. long; using the cube root-of-two rule, however, the dimensions would be 18 ft. high, 28.8 ft. wide and 46.1 ft. long. If the room were small and more nearly cubical in shape, the direct ratio would give dimensions 18 ft. high, 22.5 ft. wide and 28.8 ft. long. A graph of values for preferred room dimensions is illustrated.

One of the chief exponents of the use of polycylindrical surfaces for acoustical treatment of rooms is Dr. C. P. Boner of the University of Texas. After a series of exten-

sive tests in such rooms, a number of conclusions, objective and subjective, were drawn:

(1) The sound level decay in these rooms appears to be more uniform and more nearly logarithmic than in rooms with straight flat surfaces.

(2) At wavelengths close to the transverse cylinder dimension, the absorption at this critical frequency is greater than other portions of the audio frequency spectrum. If dimensions that vary randomly are chosen it is possible to obtain a flatter frequency response characteristic.

(3) A number of coats of paint or varnish on the plywood surface tends to increase the reflecting power of the surfaces with increasing frequency particularly above the critical frequency mentioned above. This compensates for increasing atmospheric absorption as the audio frequency increases.

(4) Results of tests show that painting or varnishing plywood has the maximum effect on frequencies above 10 kilocycles. With plywood cylinders it is possible to construct rooms from 1,000 to 6,000 cu. ft. to have essentially constant reverberation time-frequency characteristics from 40 cycles to 17 kilocycles.

(5) Measurements have shown that many existing studios reach the optimum reverberation time for only a narrow band of the audio frequency spectrum between 3 and 7 kc, and that flutter and "brittleness" result. The polycylindrical diffusive designs avoid this difficulty.

(6) For piano, organ, strings, reeds and vocal music, a flat reverberation time-frequency characteristic is acceptable to operators and performers alike. In a studio of approximately 5600 cu. ft. volume, this response from 40 cycles per second to 17 kilocycles per second varies between the narrow limits of 0.45 second to 0.55 second over the entire range when the studio employs the diffusive design. For brass instruments, however, particularly the trumpet and the trombone, the performers hear their own high frequency output in the new type of studio where they never heard it before in the conventional type. The result is that the performers are displeased, but indications are that it is preferable from the listener's standpoint.

TABLE I

	Frequency in Cycles Per Second					
	128	256	512	1024	2048	4096
	Percentage—Sound Absorption					
High-frequency element ..	20	46	55	66	79	75
Low-frequency element ..	66	60	50	50	35	20
Triple-tuned element	66	61	80	74	79	75

(7) From the viewpoint of orchestra players, the diffusive design enables the orchestra as a unit to maintain a high level of volume when necessary, much more easily than with the conventional design. This may be due to the fact that the polycylindrical surfaces in general reduce the effect of "hollowness" by diffusing the incident sound wave without diminishing the intensity too greatly.

(8) In broadcast studios having polycylindrical surfaces, the flat characteristics above 10 kilocycles may prove to be annoying to certain speakers. This calls for a drooping characteristic above 10 kilocycles and can be obtained by the simple expedient of adding a rug to the studio floor. This has the effect of drooping the characteristic above 10 kilocycles since rug absorption is selectively high in this range without affecting the reverberation time over the audio frequency range below 10 kilocycles.

(9) The placement of a microphone is not critical provided it is placed away from the performing group rather than in its midst. In addition, only a single microphone pickup is necessary because of the excellent diffusion pattern in these rooms.

(10) To reduce resonances, the room dimensions are critical and should follow the cube root-of-two rule for optimum conditions.

Panel Advantages

Rettinger summarizes the advantages of the convex wood panels in a confined space as follows:

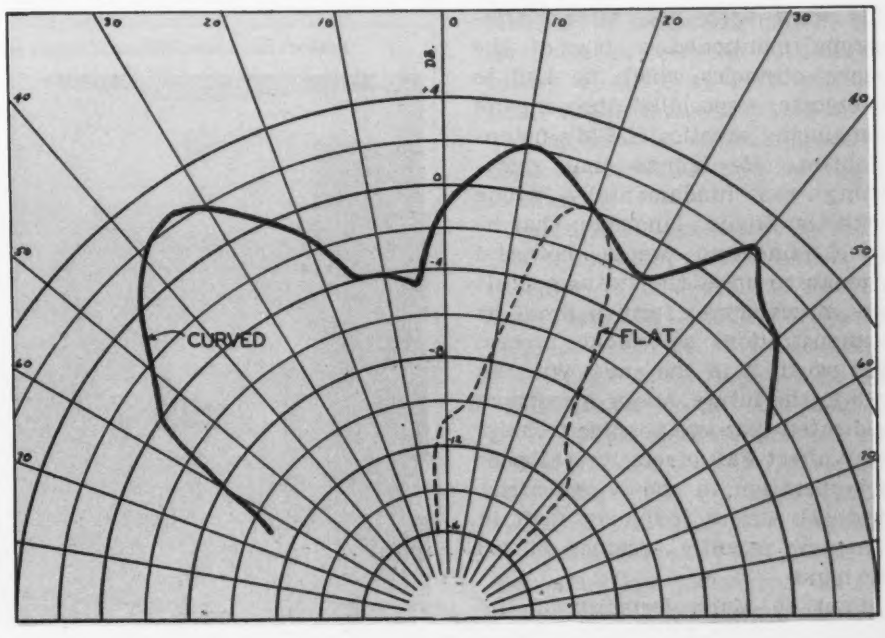
(1) A more uniform distribution of sound levels due mainly to the fact that the sound is reflected with a longer wavefront particularly at high frequencies.

(2) The surfaces vibrate, creating within themselves an area sound source, which takes on a special importance at the low frequencies.

(3) Enables the designer to specify walls which are more absorptive at the low frequencies than at the high frequencies, thus compensat-

(*Continued on page* 127)

Polar diagram illustrating reflected sound distribution from curved and flat surfaces



Engineers Study FM Operation

Four-day technical clinic staged by REL covers modern broadcast transmission and reception problems—New equipment demonstrated

• With more than 150 individuals in attendance, Radio Engineering Laboratories early in January staged an FM engineering clinic in its Long Island (N.Y.) plant that drew engineers from all over the United States and from as far away as Australia and Africa. For four days they studied FM engineering from every angle, viewed several new pieces of REL equipment. The registration list was studded with the names of FM notables. And one of their worries, simmering to the top, is the apprehension that FM may be sold short by a minority group of receiver manufacturers whose products are not truly engineered to give listeners all the benefits of honest FM quality.

A highlight of the conference was Major Armstrong's duplication of his January, 1940, FM demonstration which resulted in assignment of an 8 mc FM band by the FCC. Reflecting over the years of his work with FM, Major Armstrong mentioned a few of the many obstacles which he had to overcome, especially the one of convincing skeptics of FM's potentialities. He opined that something was fundamentally wrong with the English language; that he could find no words powerful enough to upset the status quo. It was necessary to furnish proof by demonstration, a tedious process but worth it in the end. With an eye to the future, Major Armstrong indicated that two possible troubles may affect FM adversely: (1) poor set operation in the fringe areas, and (2) serious frequency drift in the new recently assigned 88-108 mc band.

Paul de Mars, formerly of the pioneering FM Yankee Network, in response to a question on the subject of circular polarization, expressed belief that this form of polarization would meet difficulties since no high-power, high-gain antennas of this type are available; that horizontal polarization now used by most broadcasters is satisfactory and may take hold for good.

REL Chief Engineer Frank Gunther and the new FM monitor receiver

On the other hand, C. M. Braum, FCC FM engineer, stated that circular polarization may have its points when more is known about it; that one almost certain advantage is the greater freedom a set-owner has in erecting his receiving antenna. Radio consultant Stewart Bailey, discussing FM service, is also warm to circular polarization but cautioned that more should be known about the subject before standards are set for or against it; that many set locations, as in apartments, prohibit any antenna more elaborate than a simple piece of wire.

Both Bailey and Braum believe that though conversion to circular polarization may shrink the secondary coverage for a given antenna power, the holes in the primary coverage pattern may be

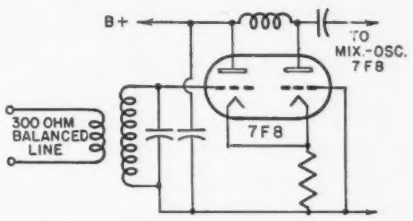
Project Engineer Wilbur Thorpe addressing one of the crowded sessions

better filled and thus more sets would be serviced than were lost in the secondary area. Bailey joined others in a plea for higher power for broadcasters. If doubling the power increased the listener coverage by 10%, it was pointed out this better service to the public was sufficient justification.

F. M. McIntosh, Consulting Engineer, discussed some economic aspects of FM transmitting antennas. In as much as the cost of FM antennas is a considerable portion of the total station cost, it is well to make a comparison between a high-gain antenna with a low-power transmitter on the one hand, and a lower-gain antenna with a higher-power transmitter on the other.

C. R. Cox of the Andrew Company, manufacturer of transmission line equipment, discussed recent mechanical advances in transmission line fittings and tower hardware. Broadcasters prefer the 1⅝ in. and the 3⅛ in. sizes of transmission lines having efficiencies of 75% and 80% respectively. At the higher frequencies where attenuation and mismatch take on added importance, cost becomes a major factor. Four hundred feet of ⅞ in. line cost about $1500 including installation charges. For the same length of 6⅛ in. line, the total cost would run to nearly $10,000. Cox then illustrated three curves showing minimum temperature rise, attenuation and electric field on the inner conductor surface plotted as a function of diameter ratio. A compromise was obtained at the intersection of the three curves corresponding to a diameter ratio of 2.3 and a transmission line characteristic impedance of 51.5 ohms, the RMA standard.

Featured in all REL equipment discussions were actual demonstrations of the equipment in operation. M. H. Jennings of the research department demonstrated the Armstrong dual-channel modulator. He demonstrated that it was impossible to tune the various multiplier circuits to the wrong peak. For fast tuning, the plate circuit of one stage and the grid circuit of the succeeding stage can be measured for optimum conditions from a single jack. Broadcasters saw a demonstrator change the modulator from one frequency to another in eight minutes. An effective demonstration showing that modulator adjustments are not critical was illustrated when all circuits were thrown out of tune, reducing the rf voltage by 30%. It was difficult to detect any difference in the audio output when a transcription program was run through the modulator system.



Cathode-follower grounded-grid rf input stage used in REL receiver model 646

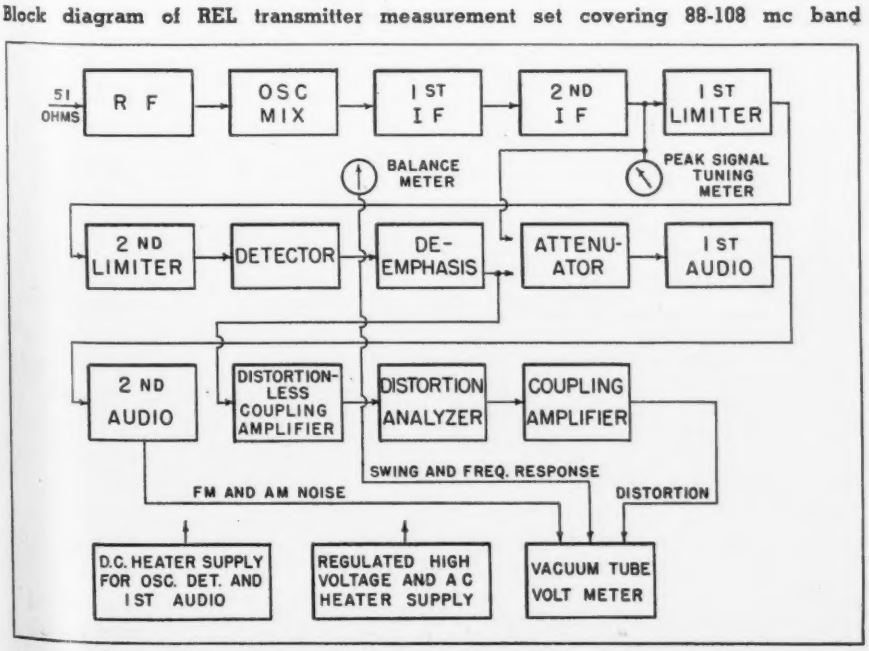
REL uses tetrodes in push-pull for the final amplifier stages naming as advantages the elimination of even harmonics, as well as the important fact of reduced off-the-air time. REL transmitters in power steps of ¼, 1, 3, 10, and in the near future, 50 kw, will be manufactured.

Describing the new REL Model 646 receiver for studio monitoring of both high and low FM bands, J. Day mentioned that one distinguishing feature was the input circuit. A double-triode 7F8 is used for the receiver input. The first half is a cathode follower and operates into the second triode section, a grounded-grid amplifier. The less-than-unity gain of the cathode follower does not decrease the signal-to-noise ratio, since circuit noise is subject to the inherent degenerative action of this type circuit. The receiver has a peak signal tuning meter as well as a zero-balance meter, one indicating limiter action, the other correct operating point on the discriminator curve.

The REL Model 600 frequency and modulation monitor is the first commercial model to be approved by the FCC for FM station use. The unit is designed to indicate both the instantaneous percentage of modulation and the average center frequency of an FM transmitter. The accuracy of frequency indication is ± 200 cycles, well within the FCC tolerance of ± 1,000 cycles. Modulation indication can be had for ± 105 kc deviation with an accuracy of ± 3% at 100% modulation. Facilities are provided for an over-modulation alarm, remote indication facilities and an audio monitor.

Latest REL equipment is model 645 transmitter measurement set designed to measure FM and AM noise down to — 75 db, frequency response from 20 to 20,000 cycles, FM carrier swing of ± 150 kc and FM distortion to not less than 0.3 of 1%. The measurement set embodies a distortionless FM receiver of low sensitivity and high stability including the necessary amplifier, attenuators, meters and filters for inspecting and measuring the output of the transmitter under test.

Block diagram of REL transmitter measurement set covering 88-108 mc band



Duoband Receiving Antenna for FM-TV

By JAMES ROBERT MARSHALL and ROBERT WAKEMAN
Chief Electronic Engineer — Development Engineer
Dielectric Products Co. — Allen B. DuMont Labs
Jersey City, N. J. — Passaic, N. J.

Design of efficient reception equipment, relatively insensitive to interference, adaptable to TV frequencies, with low standing wave ratio

• The rapid growth of home television requires an effective receiving antenna system covering the television bands of 44 to 88 mc and 174 to 216 mc plus the FM band of 88 to 108 mc. To supply this need the antenna herein described has been designed. It is intended to be used where a simple low cost system is needed.

The antenna should be moderately insensitive from 108 to 174 mc as an examination of the "Television Interference Chart"[1] will show. It should also be capable of terminating either a 72-ohm coaxial line

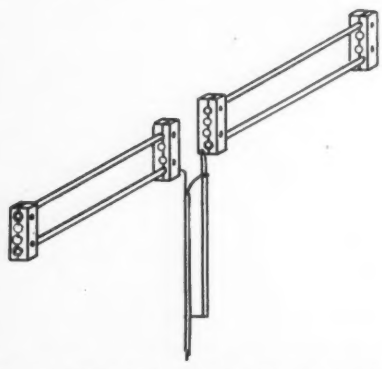


Fig. 1—First lab model which provided for varying effective thickness of arms

or a 72-ohm balanced line, to permit the use of the former where the signal-to-noise ratio is poor, or an inexpensive two-wire line where good reception conditions prevail.

In order to obtain a broadband receiving characteristic, it is necessary for the antenna to have a large effective ratio of cross section to length. Accordingly, an experimental halfwave dipole was made composed of two arms. Each arm consisted of two lengths of ⅜ in. OD tubing cut to one-quarter wavelength at 60 mc and assembled as in Fig. 1. The separation between these sections was made variable, and voltage standing wave ratio

THE antenna should have approximately the same acceptance as a halfwave dipole over each of the thirteen television channels, and should produce a comparable field pattern. In addition it should possess some degree of unidirectivity throughout the upper band to aid in the reduction of noise and multipath transmission problems. Such difficulties in the lower band could be minimized by arranging the attachment of parasitic reflector elements in difficult locations.

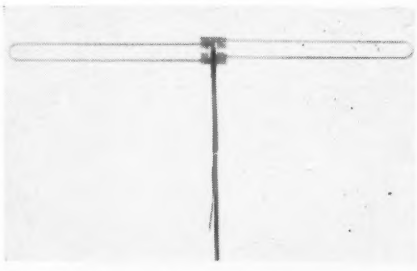


Fig. 2—Second laboratory model dipole without addition of modifying elements

versus frequency characteristics were investigated to obtain the desired broadband characteristic. The length of the arms of the dipole was then adjusted for the 44 and 88 mc region, care being taken not to cover any appreciable portion of the 88 to 108 mc FM band.

A second model antenna (Fig. 2), made up of two ⅜ in. OD "U" shaped arms with the spacing and lengths determined above, showed

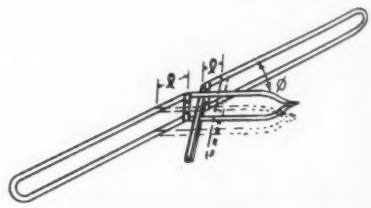


Fig. 3—Antenna showing variables ϕ and l which determine field pattern

substantially identical results. It was also found that the voltage standing wave ratio characteristic from 174 to 216 mc was satisfactory for a receiving antenna, but as expected, the field pattern did not meet the specifications in this region.

It was decided, therefore, to make use of a broadband halfwave dipole resonant at 180 mc connected to the transmission line terminals in parallel with the main elements of the antenna. The result was an increase in signal acceptance to the front and rear. The next step was to vary the phase and magnitude of the current in the shorter dipole arms and to vary the angle between these arms and the main element in order to obtain a more desirable field pattern. This was accomplished mechanically by varying ϕ and l as shown in Fig. 3.

It was found that to provide a better voltage standing wave ratio versus frequency characteristic from 174 to 195 mc, an acceptable field pattern characteristic, and a

[1]SOURCES OF TELEVISION INTERFERENCE —Supplement to "Electronic Industries" 1946, Dr. T. T. Goldsmith.

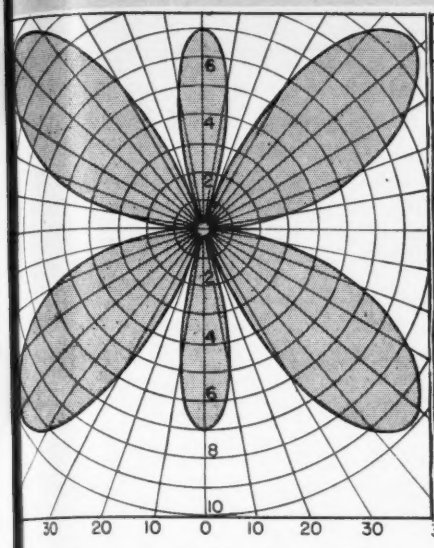


Fig. 8—Theoretical field pattern at 180 mc without modifying elements, showing four main and two supplementary lobes

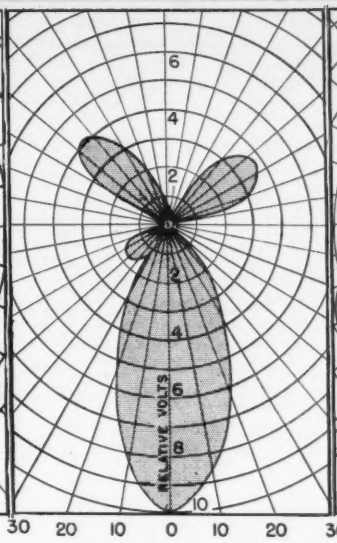


Fig. 9A—Field pattern measured at 180 mc on the antenna with ϕ and l adjusted for optimum unidirectivity

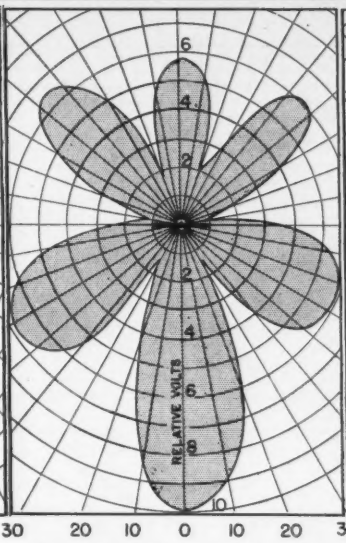


Fig. 9B—Field pattern measured at 180 mc on the final model of the antenna with modifying elements attached

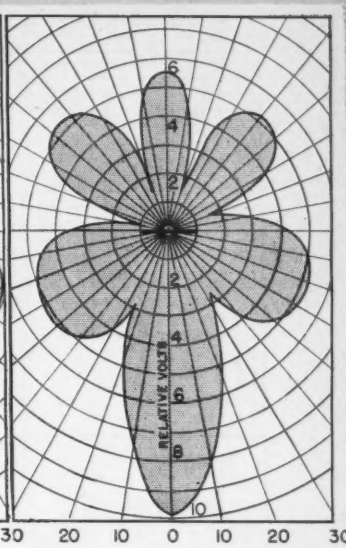


Fig. 9C—Field pattern measured at 190 mc on the final model of the antenna with modifying elements attached

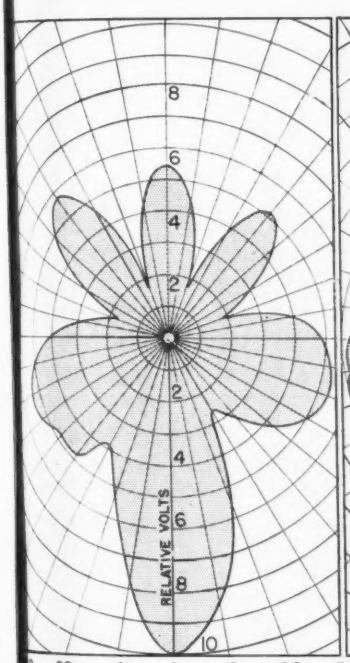


Fig. 9D—Field pattern measured at 200 mc on the final model of the antenna with the modifying elements attached

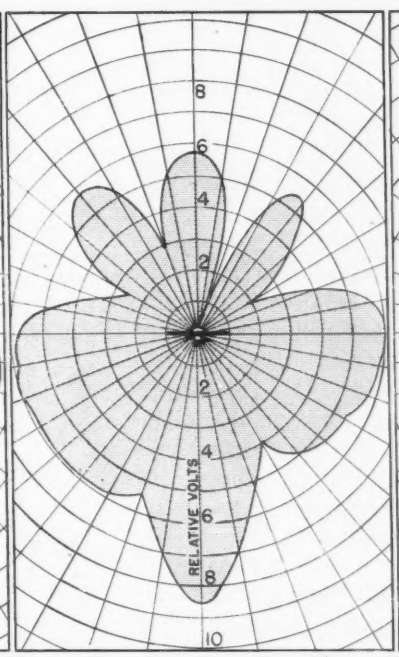


Fig. 9E—Field pattern measured at 210 mc on the final model of the antenna with the modifying elements attached

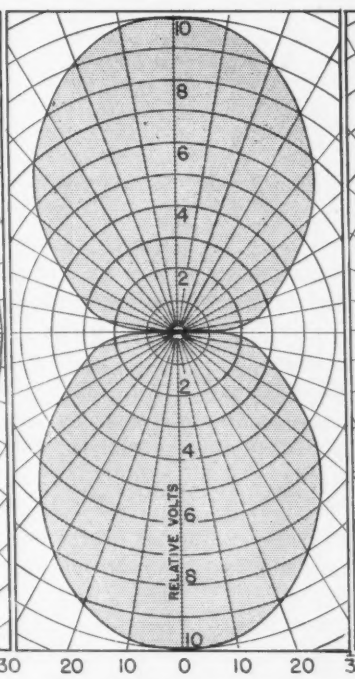


Fig. 9F—Field pattern measured at 80 mc on the final model of antenna with the modifying elements attached

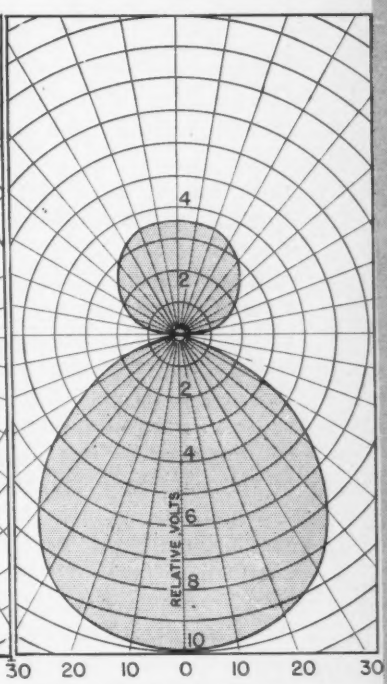


Fig. 14A—Field pattern measurements at 57 mc with reflector unit attached showing typical unidirectional characteristics

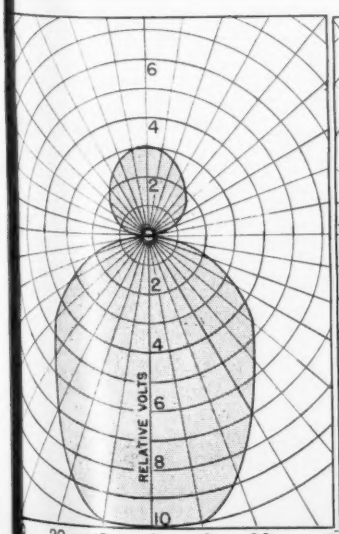


Fig. 14B—Field pattern measurements at 69 mc with reflector

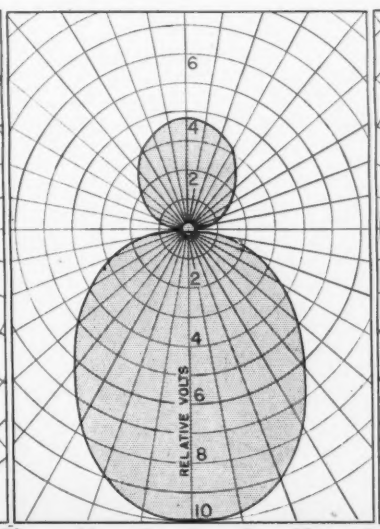


Fig. 14C—Field pattern measurements at 79 mc with reflector

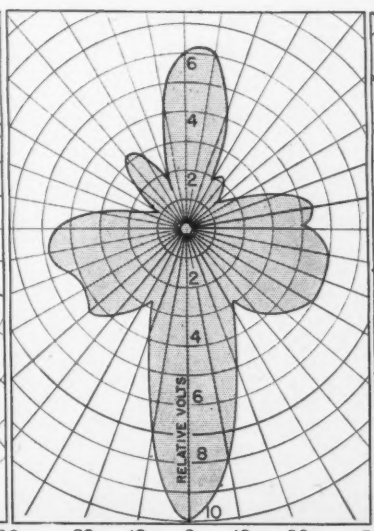


Fig. 15A—Field pattern measurements at 210 mc with reflector

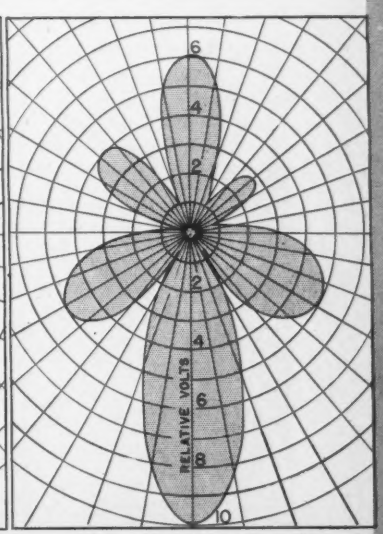
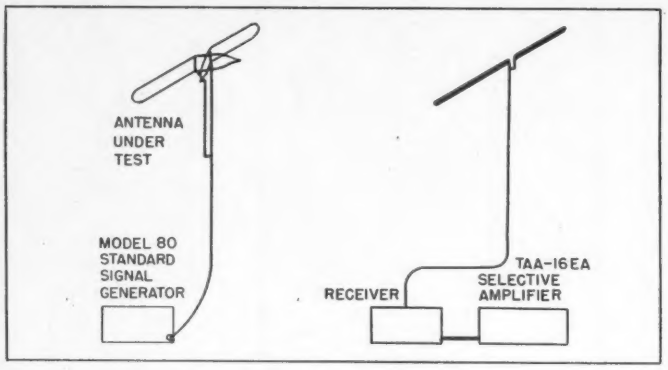
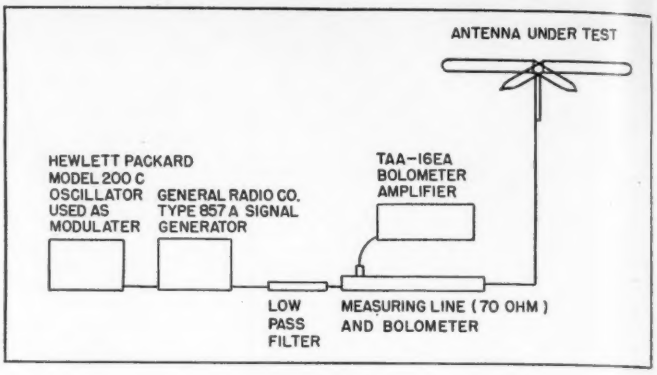


Fig. 15B—Field pattern measurements at 180 mc with reflector





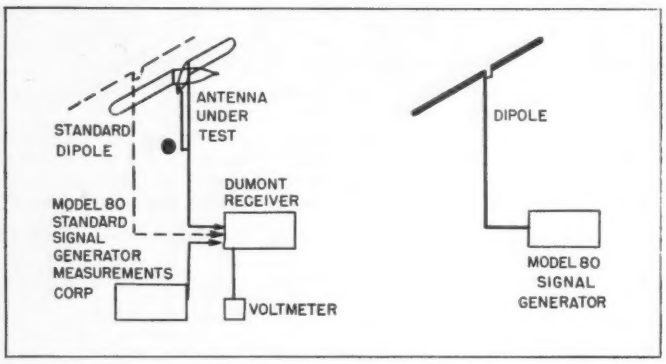


Fig. 5 (above, left) — Equipment arranged for field pattern measurements. Fig. 6 (above, right) — Equipment arranged for voltage standing wave ratio measurements. Fig. 7 (left) — Equipment arranged for antenna gain measurements

reduction in the cost of manufacturing, the dimension l could be reduced to zero.

While the modifying elements in their final position ($\phi = 50°$) caused an increase in voltage standing wave ratio characteristic from 174 to 195 mc., it seemed probable that the broadband characteristic could be improved by the proper design of the balancing transformer, Fig. 4, when the antenna is used with coaxial line.

All field pattern measurements were made in a plane containing the elements of the antenna and perpendicular to the supporting mast. The block diagram (Fig. 5) shows the arrangement of the apparatus for test. The signal generator was adjusted to a modulation at frequency of 1000 cps. The selective amplifier also was tuned to 1000 cps so as to pass the signal and reject a large portion of noise from the receiver.

Voltage standing wave ratio measurements were made using the equipment arranged as shown in Fig. 6. The bolometer and amplifier were calibrated in a conventional manner and measurements were made only of the voltage standing wave ratio with reference to the measuring line characteristic impedance (70 ohms). All measurements were made on the antenna through 25 ft. of RG-59/U cable.

Polar curves of field pattern data are presented to show characteristics before and after the modifying elements were attached to the antenna. The field pattern measured on the second model of the antenna before these elements were added is shown in Fig. 8 at 180 kc. This is representative of the condition that exists from 174 to 216

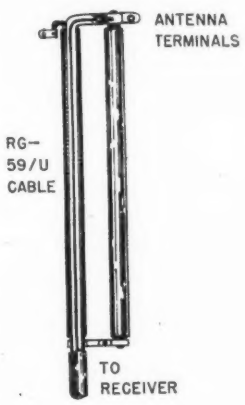
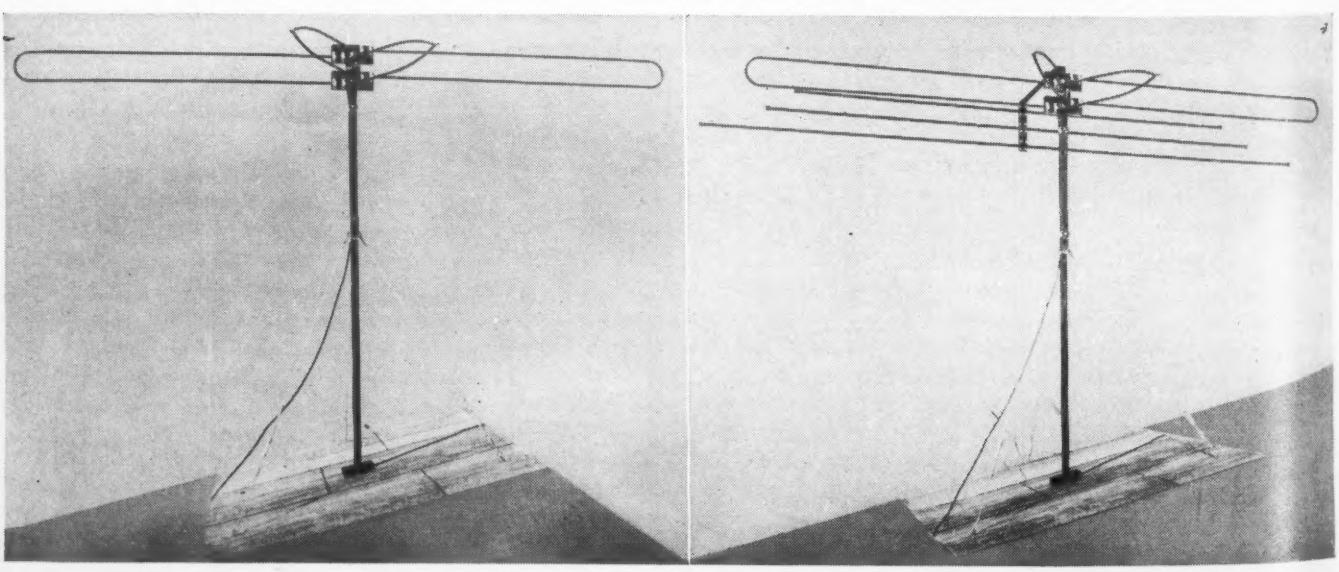


Fig. 4—Detail of balancing transformer

Fig. 10 (left)—Final model of antenna and, Fig. 13, with reflector unit attached



mc. It will be noted that this condition is unsatisfactory from the standpoint of proper orientation of the antenna. After the modifying elements were added, and ϕ and l varied as shown in Fig. 3, an optimum condition of unidirectivity was produced (Fig. 9a) as shown by the field pattern measured at 180 mc. When the dimension l was reduced to zero, as previously described, the field pattern shown in Figs. 9b, c, d and e were obtained.

All of the following data taken were on the final model of the antenna shown in Fig. 10 to determine its electrical characteristics. The variation of voltage standing wave ratio with frequency, shown by the curve in Fig. 11, indicates the broadband characteristics of the antenna connected to 70 ohms resistance. The broken curve of Fig. 12 shows the gain of the antenna relative to that of a standard halfwave dipole.

Field Patterns

Field pattern measurements made in a plane containing the elements of the antenna are shown in Fig. 9b, c, d, e and f for frequencies of 180, 190, 200, 210 and 80 mc. respectively.

Fig. 9f shows the field pattern to be essentially the same as that of a dipole at 80 mc. This curve is representative of the condition that exists from 44 to 88 mc. Fig. 9b, c, d, and e show that a good degree of unidirectivity is produced by the modifying elements. The side and back lobes of the curves are present as explained above, as a result of a compromise between the best voltage standing wave ratio chracteristic and the desired unidirectivity between 174 and 216 mc.

At the time this article was written, a simple parasitic reflector unit, which can be easily attached to the antenna, had been designed for use on channels 2, 4 and 5 in the 44 to 88 mc. band, the channels now in use in New York City. This unit consists of 3 separate reflectors, one for each of the three frequencies 57, 69 and 79 mc. The field pattern produced by the combination of antenna and reflector unit shown in Fig. 13 is essentially unidirectional. These field pattern curves taken in the plane containing the elements are shown in Fig. 14a, b and c. It was also found that this unidirectional characteristic was maintained throughout each channel. The effect of the reflector unit at the 174 to 216 mc. band causes a slightly improved unidirectional field pattern characteristic as shown in Fig. 15a, and b. The voltage standing wave ratio characteristic with reference to 70 ohms is shown in Fig. 16.

It is known that reflectors effective for the remaining three channels in the 44 to 88 mc. band may be added to the antenna; however, it is expected that the above characteristics will be gen-

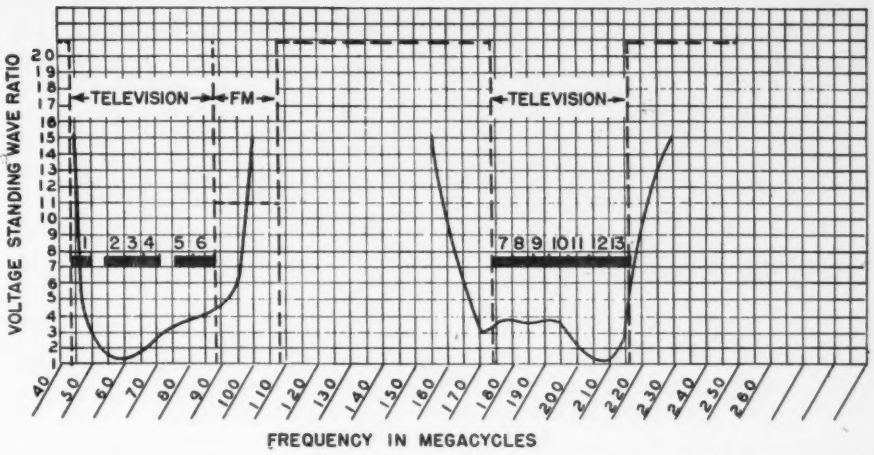


Fig. 11—Standing wave ratio vs. frequency characteristic for final antenna model

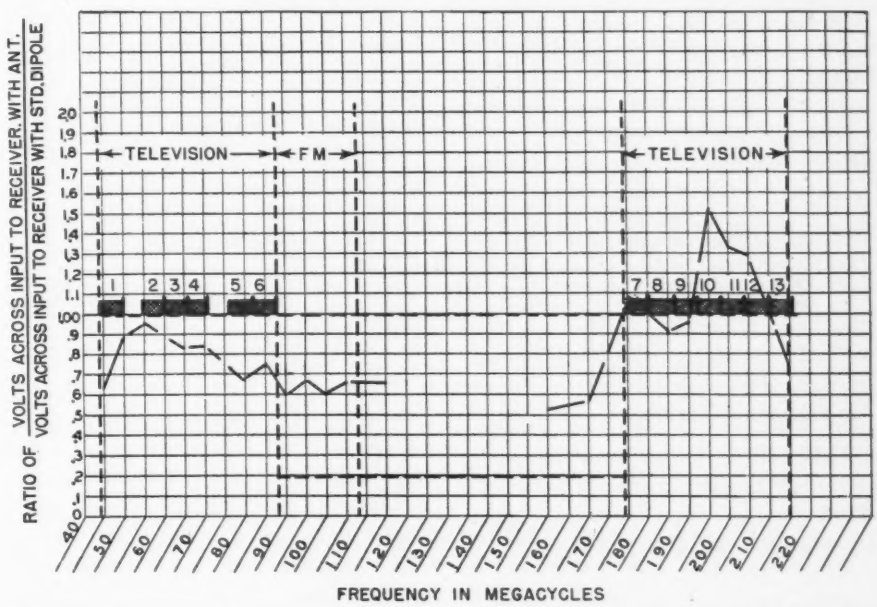
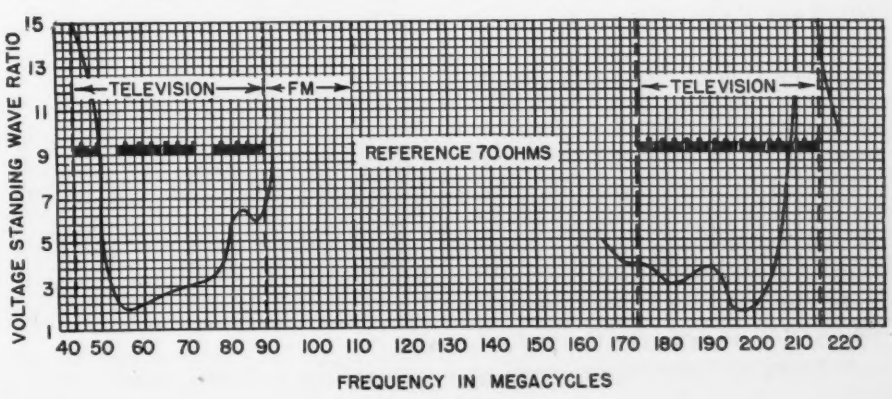

RATIO OF VOLTS ACROSS INPUT TO RECEIVER WITH ANT. / VOLTS ACROSS INPUT TO RECEIVER WITH STD. DIPOLE
TELEVISION
FM
TELEVISION
1 2 3 4 5 6
7 8 9 10 11 12 13
FREQUENCY IN MEGACYCLES

Fig. 12—The curve of comparison of antenna gain with standard dipole vs. frequency

Fig. 16—Voltage standing wave ratio vs. frequency for antenna and reflector unit


VOLTAGE STANDING WAVE RATIO
TELEVISION
FM
REFERENCE 70 OHMS
TELEVISION
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
FREQUENCY IN MEGACYCLES

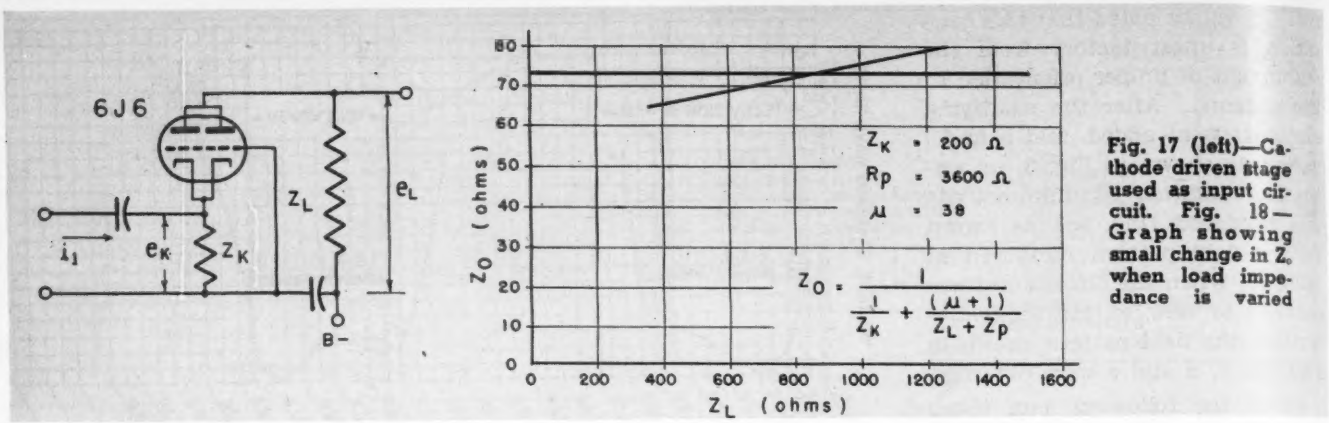


Fig. 17 (left)—Cathode driven stage used as input circuit. Fig. 18—Graph showing small change in Z_o when load impedance is varied

erally affected. The effect of all of these possible combinations of reflectors on the antenna characteristics has not as yet been investigated.

Input Circuit

The input circuit used in connection with this antenna is the cathode driven stage shown in Fig. 17. This circuit is known to have excellent stability, good gain, and a fairly constant input impedance; and consequently is quite desirable for television service.

If the input admittance, Y_o, looking into terminals (1), (2) is defined as i_1/e_k, then Yo is given approximately by the expression:

$$Y_o = \frac{1}{Z_k} + \frac{\mu+1}{Z_L+R_p} \qquad (1)$$

With 100 volts applied to the 6J6 and with Z_L approximately 1000 ohms (dictated by broadband considerations), the tube constants are such as to make the second term on the right side of equation (1) equal to about 0.01 mho. Consequently, regardless of how large Z_k becomes, the input impedance can be no greater than 100 ohms with this circuit. Z_L is normally a broadband resonant circuit and will vary somewhat as the set is tuned. Obviously, Y_o will also vary. However, this variation can be minimized by making Z_k a small pure resistance.

Fig. 18 is a graph of $Z_o = \frac{1}{Y_o}$ versus Z_L and shows clearly the small change in Z_o when the load impedance is varied over wide limits.

Defining the gain of the stage as the ratio of e_L to e_K, the approximate expression is:

$$G = \frac{Z_L(\mu+1)}{Z_L+R_p} \qquad (2)$$

This expression is derived from the fact that Z_o is equal to the source impedance (in this case the characteristic impedance of a transmission line). This being true, e_k is the voltage measured across the flat line and consequently neither the source impedance nor Z_K enter into the gain equation. Therefore, the gain is not a function of Z_K or Z_o and need not be considered in the choice of input impedance.

The preceeding argument leads to the following conclusions: A cathode driven input stage will present an essentially constant input impedance to the transmission line despite considerable variation in load impedance. This permits a good impedance match over the entire band. Equation 2 shows that the gain of such a stage increases with an increase in gm. Hence, it becomes desirable to use a tube having a high gm. in this circuit. However, as previously shown, a high gm. automatically produces a low input impedance and in the example given, this impedance is less than 100 ohms.

It should be noted that a low impedance input circuit possesses certain other advantages. It permits the use of a low impedance parallel line, or in noisy locations, a 72-ohm coaxial cable. It is also very probable that a low impedance input circuit will be less efficient as a radiator for the local oscillator, such radiation being a familiar cause of interference in neighboring receivers. In view of these considerations, the antenna herein described was designed to have a nominal impedance of approximately 72 ohms.

Optical Systems for TV Projection Receivers

One of the complex processes by which American Optical Co. produces spherical mirrors and correcting lenses which are the basis of many projection systems

RTPB Investigates TV Sound Systems for Color

Committee on UHF transmission considers all available methods for comparison with currently standard separate carrier transmission

• Commercial broadcasters of black-and-white television find their audiences on a whole are well satisfied with the sound transmission that accompanies the images. And they should be—because it is sent by the usual type of FM apparatus and should possess the high fidelity, noise-free characteristics associated with this type of transmission.

For such aural transmissions accompanying commercial television pictures the FCC standards specify: (a) FM with a maximum frequency swing of 75 kc; (b) pre-emphasis as in regular FM broadcasting; (c) unmodulated carrier power not less than 50% and not more than 100% of the peak radiated power of the picture transmitter; (d) audio equipment capable of transmitting the band 30 to 15,000 cycles within 2 db of the 1000-cycle level, with the noise output 60 db below the level corresponding to 100% modulation; (e) carrier frequency to be maintained within plus or minus .01% and (f) the aural carrier to be spaced 4.5 mc above the picture carrier. This is what we have today. For tomorrow's color television we may have a very different system of sound transmission. For instance, instead of using two separate transmitters, one transmitter by diplex operation may radiate both picture and sound.

Engineers have realized for some time that if the scanning rate of the picture were raised to a value commensurate with the highest aural frequency to be transmitted, then, using one of several methods, the sound could be transmitted during retrace time of the scanning beam. Systems of color television which have high scanning rates open the door for the first time to the practical use of such methods of sound transmission. It was logical, therefore, that the RTPB-RMA Subcommittee on UHF television systems, working on proposed standards for color television, should assign a sub-subcommittee to investigate methods of sound modulation for UHF television. Dr. T. T. Goldsmith (Allen B. DuMont Labs) was appointed chairman.

LISTED in tabular form on the following two pages are eight possible methods of synchronizing sound with UHF color pictures indicating advantages and disadvantages of each as viewed by RTPB-RMA committee.

The first job of the sub-subcommittee, which started with about eight members and has nearly doubled in size, was to collect information about all proposed systems. After sifting, eight methods were judged worthy of examination and discussion. More may be added in the future. The next task was to list the performance characteristics of the sound systems and then, by means of a table (pages 64-65) to find out how each of the proposed methods compared in a side-by-side analysis.

To show the wide range of investigation, reaching from the theoretical to the very practical, some of the characteristics are listed here: Frequency Response (theoretical and practical); distortion (theoretical and practical); signal-to-noise ratio; cross-talk (picture in the sound and sound in the picture); multipath effects; complexity (receiver and transmitter); ease of receiver operation and servicing; effects of hum modulation of receiver heterodyne oscillator on sound reception; reduction in peak amplitude of TV to accommodate sound; reduction in bandwidth available for picture signal; troubles in sound reception when TV receiver is not synchronized; troubles due to transmitter non-linearity; development stage of proposed system.

Systems considered were as follows: First we have the present, standard method utilizing separate HF carriers for picture and sound, the former being AM, the latter FM. A variation of this, suggested for the UHF band, is to use AM for both. Another variation—and one widely supported by the subcommittee—is known as the Dome-G.E. Co. proposal. This specifies the present standard method of transmission with the additional requirements: (a) that the picture carrier should always have a minimum value of 15% so that it will be available to demodulate the sound carrier; (b) that the difference in the frequency between the two carriers be constant and reasonably free from FM caused by spurious or picture signal frequencies. The result of this method would be a simplified receiver, untroubled by local oscillator drift.

Under the heading of Diplex Operation we have a group of methods all of which have to do

(*Continued on page* 140)

COMPARISON OF METHODS OF TRANSMISSION OF TV SOUND SIGNALS

	SYSTEM	A. Standard Separate Carriers, Picture AM and Sound FM	B. FM of Main Image Carrier During Retrace Interval	C. Bursts of Frequency Modulator Subcarrier During Retrace Interval	D. Width Modulated Pulses During Retrace Interval	E. Time Modulated Pulses During Retrace Interval	F. FM of Continuous Subcarrier of Main Image Carrier (±7.5% modulation)	G. Standard Separate Carriers Received by G.E. Method (15% min. image carrier)	H. Standard Separate Carriers, Picture AM and Sound AM
1	FREQUENCY RESPONSE (Theoretical)	Unlimited	Limited to 50% of line frequency.	Limited to 50% of line frequency.	Limited to 50% of line frequency.	Limited to 50% of line frequency.	Unlimited	Unlimited	Unlimited
2	FREQUENCY RESPONSE (Practical)	30—15,000 c.p.s.	30—13,000 c.p.s. (37,800 lines/sec.)	30—13,000 c.p.s. (37,800 lines/sec.)	30—13,000 c.p.s. (37,800 lines/sec.)	30—13,000 c.p.s. (37,800 lines/sec.)	30—15,000 c.p.s.	30—15,000 c.p.s.	30—15,000 c.p.s.
3	DISTORTION (Theoretical)	Zero	About 2%	About 2%	About 2%	About 2%	0.1 of 1%	0.1 of 1%	Zero
4	DISTORTION (Practical)	Less than 2%	Less than 5%	Less than 5%	Less than 5%	Less than 5%	Less than 2%	Less than 2%	Less than 2%
5	Signal-to-Noise Ratio Improvement Over AM, Assuming Equal Amplitude of Sound Part of Radiated Signal and Assuming Pre-emphasis in All Systems	12.99	67	41	1.58	1.12	12.99	12.99	1.0
6	Equivalent Carrier Amplitude in Terms of Peak Picture Transmitter Voltage	0.7	1.0	0.336	0.375	0.375	Varies with picture MINIMUM = .0336 AVERAGE = .0375 MAXIMUM = .0375	Varies with picture MINIMUM = 0.21 AVERAGE = 0.545 MAXIMUM = 0.73	0.7
7	Signal-to-Noise Ratio Improvement Over AM as Adjusted for Actual Radiated Amplitude	12.99	95.7	19.7	0.847	0.600	MINIMUM = 0.623 AVERAGE = 0.697 MAXIMUM = 0.697	MINIMUM = 2.94 AVERAGE = 7.63 MAXIMUM = 9.48	1.0
8	Relative Ranges at Threshold of 1:1	0.604	0.197	0.135	0.0707	0.0554	0.165 (Avg. & Max.)	MINIMUM = 0.277 AVERAGE = 0.446 MAXIMUM = 0.516	1.0
	Signal-to-Noise Ratio (times 100)	60.4	19.7	13.5	7.07	5.54	16.5	Min. = 27.7 Avg. = 44.6 Max. = 51.6	100
9	Cross-talk Picture Into Sound (no multipath)	Negligible	Negligible	Negligible	Negligible	Negligible	Low	Negligible	Negligible
10	Cross-talk Sound Into Picture (no multipath)	Low	May prove troublesome	Negligible	Low	Negligible	Low	Negligible	Low
11	Multipath Effects	Doesn't produce cross-talk. May distort sound.	Picture unlikely to distort sound, but multipath may distort sound. Sound produces mottled bars on picture, and may distort sync. pulses.	Field frequency hum may occur on sound. Mottled sound bars may appear in picture.	Distortion of sound may be serious. Sound may impair synchronization.	Distortion of sound may be serious. Sound may impair synchronization.	Doesn't produce cross-talk. May distort sound.	Doesn't produce cross-talk. May distort sound.	Doesn't produce cross-talk. Sound negligibly distorted.
12	Complexity of Receiver	Requires two IF channels and sound traps but permits poor receivers limited in video bandwidth without losing sound quality.	Requires only one IF. No rejection traps. Simpler sync. separation, but requires flat IF response.	Requires only one IF. No rejection traps. Permits design of poor receivers with limited bandwidth.	Requires only one IF. No rejection traps. Requires squelch.	Requires only one IF. No rejection traps. Requires squelch.	Requires only one IF. No rejection traps in IF but one required in video amplifier. IF must be somewhat wider with 100% transmission.	Requires only one IF. Requires IF and video rejection traps. Requires only slightly wider IF.	Requires two IF's. Requires IF traps, but permits poor receiver limited in video bandwidth without losing sound.

	SYSTEM	A. Standard Separate Carriers, Picture AM and Sound FM	B. FM of Main Image Carrier During Retrace Interval	C. Bursts of Frequency Modulator Subcarrier During Retrace Interval	D. Width Modulated Pulses During Retrace Interval	E. Time Modulated Pulses During Retrace Interval	F. FM of Continuous Subcarrier of Main Image Carrier (±7.5% modulation)	G. Standard Separate Carriers Received by G.E. Method (15% min. image carrier)	H. Standard Separate Carriers, Picture AM and Sound AM
13	Complexity of Transmission	Two transmitters required.	One transmitter. Must be capable of wide band AM and wide band FM.	One transmitter. Signals can be sent over single cable.	One transmitter. Signals can be sent over one cable.	One transmitter. Signals can be sent over one cable.	One transmitter. Must have wider band and is much more stringent on transmitter linearity.	Two transmitters required. Carrier difference frequency must be reasonably free from picture or spurious FM.	Two transmitters.
14	Ease of Receiver Operation	No squelch needed. Requires tuning to within plus or minus, about 50 kc.	Requires tuning only to within plus or minus about 1000 kc.	Relatively simple. Tuning limited only by picture quality desired. Line sync. must be maintained to hear sound. Probably ±1000 kc.	Very simple. Tuning limited only by picture quality. Line sync. must be maintained; squelch needed to eliminate squeals when sync. fails. Probably ±1000 kc.	Same comments as for System D in preceding column. Probable tuning range ±1000 kc.	Very simple. Tuning limited generally by picture quality. Not necessary to maintain synchronization. No squelch needed. Probable tuning range ±1000 kc.	Very simple. Tuning limited generally by picture quality. Not necessary to maintain synch. No squelch needed. Probable tuning range ±1000 kc.	Relatively simple. Tuning limited by the sound IF channel width. No squelch needed. Probable tuning range ±125 kc.
15	Ease of Receiver Servicing	Requires adjustment of large number of IF trimmers and critical traps. Requires a signal generator.	Relatively simple. No traps to align. No squelch to adjust. Sync. circuits are simpler than in conventional receiver.	Relatively simple. Only one standard FM discriminator to be adjusted. Can be done with radiated signals.	Probably somewhat more difficult than System A. May require good oscilloscope.	Probably somewhat more difficult than System A. May require good oscilloscope.	May be serviced with simple instruments using a radiated signal instead of signal generator.	May be serviced with simple instruments using a radiated signal instead of signal generator.	May be serviced with simple instruments.
16	Effects of Receiver Local Oscillator Hum Modulation	Spurious FM of local oscillator transferred directly to sound.	Spurious FM of local oscillator transferred directly to sound.	Negligible	Negligible	Negligible	Negligible. Final sound IF set at transmitter.	Negligible. Final sound IF set by transmitters.	Not susceptible to hum FM, and in practice negligibly susceptible to AM hum.
17	Reduction in Peak Amplitude of Television Signals to Accommodate Sound	None, because of separate transmitters.	None, because of time division.	None, because of time division.	None, because of time division.	None, because of time division.	15%. This much picture carrier needed to carry sound. Possibly more reduction to obtain good linearity in P.A.	15%. This much picture carrier needed to continuously demodulate sound carrier.	None, because of separate transmitters.
18	Reduction in Bandwidth Available for Picture Signals	Probably 0.5 mc.	None, because of time division.	None, because of time division.	None, because of time division.	None, because of time division.	Probably 0.5 mc.	Probably 0.5 mc.	Possibly 0.5 mc.
19	Troubles When Receiver Image Is Not Synchronized	Independent of synchronization.	Independent of synchronization.	No sound if sync. is displaced. No squelch needed if failure is due to low signals.	Squeals in sound output unless squelch is used.	No effect unless sync. level is low. Hum then produced is 1/3 strong as sound. May be eliminated by squelch.	Independent of synchronization.	Independent of synchronization.	Independent of synchronization.
20	Troubles Due to Transmitter Non-Linearity	Generally none if cross-feed between transmitters is kept low.	Generally none since FM is used but transmitter response must be flat.	Generally none, but transmitter response must be good at subcarrier.	None. Sound does not depend on pulse amplitude.	None. Sound does not depend on pulse amplitude.	May require fairly linear transmitter to prevent saturating off the sound.	None; separate transmitters used. Cross-feed between transmitters must not be excessive.	Generally none if cross-feed between transmitters is kept low. Sound transmitter must be linear.
21	Degree of Development	Two years of field tests plus five years' commercial use.	Theoretical study and paper work. No lab. work known.	Three years lab. tests plus one year field tests in New York.	Theoretical studies in U.S.A. labs. and tests by Pye Co. in England.	PTM used by Armed Forces for several years. Used in UHF television about year ago, 2 weeks field tests. Exhaustive lab. tests.	Experimental field tests for government.	Field and lab. tests on present black-and-white television.	Extensive field tests prior to adoption of FM in 1940. Art well developed.

This table was used as one of the tools in investigating various methods of sound transmission. Probably it is the first compilation of its kind in this field and is presented to TELE-TECH readers as an interesting preliminary survey. It is subject to revision. It does not bear the formal approval of the sub-subcommittee of the RTPB or RMA.

Flanked by color and black and white receivers, FCC opens Round 2 of its public hearings looking to establishment of standards for color transmission, with Commissioners Hyde, Walker, Chairman Denny, Wakefield and Chief Engineer Jett on the bench

Color TV Demonstrations Reveal Engineering Progress

CBS sequential and RCA simultaneous color reception before FCC hearings indicate need for further development work before standards can be set up

• The first round before the FCC in Washington concluded with CBS placing in the record, in a masterly fashion, all evidence available that would support their claim that the standards they propose for commercial color TV should be adopted. At the same time, the majority of the industry, both individually and collectively, gave reasons why these same recommended standards should not be approved. The CBS system produces a tri-color sequential, 48 frame per second, 525-line, interlaced television picture. This would be radiated, together with the sound, in a 16 mc channel in the uhf band, 480 to 920 mc. At Columbia, a technical staff of over 100 headed by Dr. P. C. Goldmark, have developed such a system. This excellent piece of work, done under high-pressure, is lauded as an outstanding achievement by all in the engineering world who realize the planning, inventing and developing necessary to produce an operating system that shows pictures of the quality exhibited by CBS.

The Score at the End of Round 1. CBS had testified that their system would produce pictures 7½ x 10 in. of good color fidelity. Using their transmitter in NYC on 490 mc, they had made reception tests at 188 locations and were satisfied that suitable broadcast coverage could be obtained. This experimental system embodied all of their proposed standards. Although lacking in camera equipment for certain uses they said they could put on commercial programs in a matter of weeks if so authorized by the FCC. Supporting the CBS petition were Westinghouse, Bendix, Cowles Broadcasting Co., Zenith and Federal.

On the other side appeared RCA, Emerson, Farnsworth, TBA, Philco and others. DuMont's appearance was made later. The industry committee of RTPB-RMA reported that by majority vote, it was decided that more experimental work was necessary before color TV standards could be adopted.

The opposition attacked the CBS proposal from two angles; first, the system proposed was fundamentally so limited as to preclude future development; second, a better system not so limited, using simultaneous instead of sequential scanning, was in the early stages of development in the RCA laboratories. Specifically it was claimed that the CBS system was lacking in brilliance; in picture size; in freedom from flicker and color breakup; uneconomical of light because of necessary filters; not thoroughly tested as to propagation on the

uhf band to be used; not compatible with the present commercial black-white system so that there was no way to avoid costly obsolescence by a gradual changeover from the present standards to new color standards. The RCA simultaneous system was designed to overcome these alleged disadvantages.

A New Kind of FCC Hearing. This was the situation at the end of Round 1. At this time many thought that CBS had an even chance of having their petition granted. Then followed the history-making hearings of FCC in New York and Princeton which may be called "Round 2". These were for the purpose of witnessing tests of TV reproduction right in the courtroom, where cross-questioning could be placed in the record even as the pictures were on the screens of the receivers grouped beside the Commissioners who were hearing the petition.

Chairman Denny conducted this unusual part of the hearing in a most satisfactory manner. He gave all the interested parties full opportunity to ask for tests and to express their views. A surprising deviation from procedure of the historic past was to permit engineers to question witnesses. Heretofore, the technical men usually thought out the questions, relayed them to their lawyers, who after legal rephrasing, shot them at the witness. The reply, often in technical terms, was not always clear to the lawyer. Chairman Denny says that it saves time and is more direct to allow the engineers to ask the technical questions. The record for Round 2 will show that only a small percentage of its pages are due to the legal talent present, the engineers accounting for the bulk of it.

Round 2 opened in New York with a demonstration by Dr. Goldmark to substantiate his claim that it was contrast in the picture which one desired, not necessarily brightness. He used a simulated picture to show the improvement resulting from placing a neutral density filter in front of the picture when there is high ambient illumination in the room.

The demonstration was good when two photofloods were used to produce the ambient illumination, but when the regular room lights (rather amber in color) were substituted, the filter helped but slightly. It is true, however, that the CBS receiver, having a rotating color screen in front of the picture tube, gains somewhat in immunity to picture "washout" by room illumination. Of course, a neutral density filter (with its inherent light loss) can also be used in front of any picture source, if desired, to obtain this same effect of doubtful overall value.

Later in a side-by-side test with a bright DuMont receiver, it was evident to most observers that the image on this black-white receiver was usable after the increasing ambient light had wiped out the CBS picture. CBS did not win a point here.

The CBS Color Demonstration. Brief description of the equipment follows: The transmitting studio was on the 5th floor, 485 Madison Ave. where an Orthicon camera was used for live pickup and a Dissector tube for slides. By coaxial cable the signal was taken to transmitter W2XCS, 480-492 mc, 1 kw peak power, antenna gain between 5 and 10, omnidirectional antenna, sound transmitted on a separate carrier. Broadband receiving antennas with small reflectors (gain 6 to 8) were placed in a courtroom window. This afforded line-of-sight transmission.

Two direct-view receivers were used. One was built by Bendix, one by CBS. The light output for the resolution chart was 7 to 8 footlamberts. The picture size, 7½ x 10 in., resulted from the use of a magnifying lens in front of 10 in. diam. tube. (Incidentally, this lens, it is believed, caused more trouble than it was worth. For example, it limits the angle of view, and in a very annoying way it reflected the overhead room lights.) At the studio about six times more light intensity is needed here than for black-white pick-up.

The demonstration program opened with a girl in the studio showing colored scarfs. Also shown were girls dancing, a boxing bout, and the announcer. The writer was seated about 55 ft. from the receivers. At this distance the picture at its best was too dim, and too small, but no flicker was noted. Yet on previous occasions in the CBS viewing room the same receiver gave objectionable flicker at viewing distances of less than 10 ft. when the highlight brightness was about 19 ft. l. For a good bright picture, viewed at the normal viewing distance, 48 frames per second produce an annoying flicker for most observers.

Chairman Denny asked for tests from those present. The effect of increasing the room illumination was tried. Due to the dimness of the picture, increasing the room lighting noticeably degraded the picture quality. Mr. Shelby, to show color fringing and breakup, asked for such tests as waving a white handkerchief before the camera. No trouble due to color fringing

At Federal Courthouse FCC hearing on color TV, Dumont Counsel Col. Wm. Roberts, Director of Research Dr. T. T. Goldsmith, Jr., and Dr. Allen B. Du Mont confer

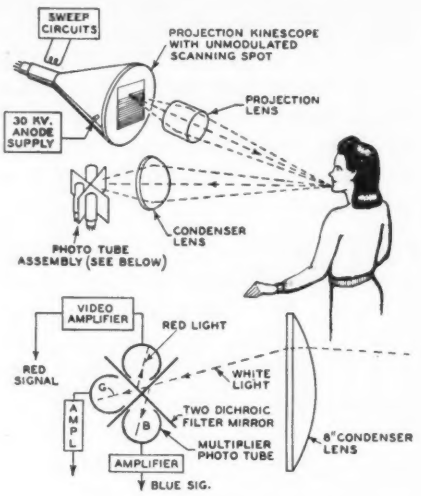
was noted by the writer. The Bendix receiver developed some trouble and it was turned off until the afternoon session.

Mr. Roberts asked for the girl in the studio to move around so that the detail furnished by the system could be better estimated. Dr. Murray suggested the showing of the resolution chart. Later, this was done, and Mr. Fink, who was called upon to read the chart, reported about 300 lines resolution.

The next demonstration was a monochrome movie. At this time and throughout all the tests the CBS receiver reproduced white as purplish blue, never white. In this test the picture again was too dim to be satisfactory. During the switching from movies to slides to studio, the pictures on both receivers were very stable. There were no synchronism troubles. However, the two CBS engineers operating the receivers transgressed one unwritten rule of TV demonstration etiquette, namely that one should not touch the controls unless absolutely necessary. The CBS men were making adjustments almost continuously. This gave a bad audience impression. It was stopped at intervals later by Mr. Denny announcing that the next test would be made with no receiver readjustments.

Color Transmission Over Coaxial Cable. The ability to transmit a usable picture over the Am. Tel. & Tel. coaxial cable linking TV stations is very important. At present, this cable passes a band about 2.7 mc wide. CBS is using a band about 9 to 9.5 mc wide for their system. It has been claimed that their pictures in color can be transmitted by cable to Washington and return, 480 miles, with no observable change in quality. To actually see this test with their own eyes, some of the engineers in the audience had traveled many miles.

While showing slides and live talent, this loop of coaxial cable to Washington and return was switched into and out of the circuit at the CBS control room. For this test it was desirable to have a sharper, clearer, brighter picture than was available in the demonstration, but observation both at a distance of 55 ft. and closer, actually indicated that there was no observable loss of picture quality. This was true whether the subject was a movie, a slide, or a person in the studio. This interesting observation makes a television engineer stop and ask himself "Why work so hard to secure a broadband system responsive up to 9 mc when observers would see no difference if it is cut off at only 2.7 mc?"



Schematic of flying spot studio pick-up for simultaneous color television

It has always been believed that for really high-definition pictures the full band does have to be transmitted, therefore it seemed to the writer that there was no fine detail in the pictures used for the tests. This was confirmed when Mr. Fink was called to read the resolution from a transmitted chart that did have plenty of fine detail. He, observing from the distance of 4 ft., reported:

	CBS RECEIVER	BENDIX RECEIVER
Studio Camera (Orthicon)		Horizontal Resolution in lines
Without Coax Loop	325 (av.)	Up to 250; again at 300
With " "	Less than 100	Less than 100
Slide Camera (Dissector)		
Without Coax Loop	275 (av.)	275 (av.)
With " "	Less than 100	Less than 100
Highlight Intensity	4 ft/l	5 ft/l

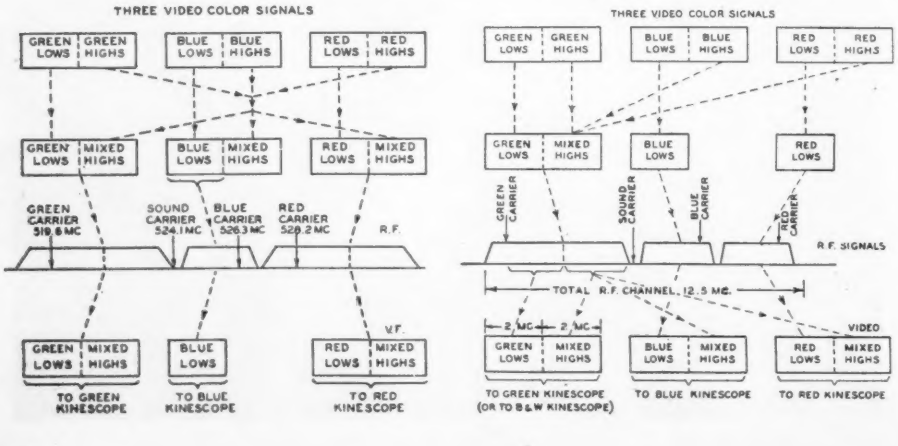
This is reassuring because it shows that a restricted bandwidth does affect picture quality. It also shows how important it is to check picture quality with a resolution chart if dependable scientific observations are desired.

Testimony by Bell Tel. Labs. At the invitation of the FCC testimony was given by Mr. Affel for Bell Telephone Labs. concering the NYC-Washington coaxial cable. A summary follows: The cable itself is the size of a pencil. It has low-loss and is shielded from external disturbances. Amplifiers appear at 5-mile intervals; they have automatic regulators to overcome line variations due to time or temperature. The transmission band is somewhat more than 2.7 mc. Transmission is flat within 1 db; the phase delay is kept at a low value and the linearity is such that undesired modulation components are at least 40 db below the desired signal. In a few years it is hoped facilities for transmitting bands 7 mc wide will be available.

CBS Table Model Receiver. Just before the hearing adjourned for the day, Dr. Goldmark demonstrated a table model color receiver. This was used with the CBS butterfly antenna that was fastened to the window glass by vacuum cups. A 5-in. cathode ray tube made by Rauland was placed behind a 11¼-in. color disc rotated by a synchronous motor.

Comparative Tests of Color and Black-White Pictures. On the sec-

Left diagram indicates the channel reduction effected by using "mixed highs" in simultaneous color TV. Right, method used to demonstrate effect of using "mixed highs"



ond day of the hearing in New York, DuMont monochrome receivers, which had been installed in the hearing room, were operated for side-by-side comparisons with the CBS receivers. The same picture was shown simultaneously on all sets. This was achieved by broadcasting the same slide or movie from the CBS color transmitter on uhf and from WNBT in black-white on hf. The DuMont equipment consisted of a very elaborate receiver with a 20-in. direct-view picture tube, a set with a 15-in. tube and a receiver having a 10-in. tube. The latter, placed beside the Bendix color receiver, gave a picture approximately the same size. The brilliance of this black-white picture tube was outstanding. It was operating at 450 ft.l. and could be run more than 50% brighter.

The side-by-side test proved that the black-white picture was superior in brightness (450 vs. 8 ft/1), superior in detail, and superior in non-flicker charcteristic (60 vs. 48 frames per sec.). The color picture was superior in artistic appeal when certain colored scenes were transmitted. This fact caused some of the audience to report that they liked color better, although they admitted some superior aspects of the monochrome image. To the majority of the 250 persons that crowded the room, the small size of the color picture compared with the easily-seen 20-in. DuMont picture meant a great deal.

Testimony by DuMont Labs. Testimony offered by Dr. DuMont can be summarized as follows: (a) more knowledge is needed regarding propagation in the band proposed; (b) networking of the CBS system is difficult due to the wide band. A simultaneous system can use three separate coaxial cables with better results. (c) Color standards should be integrated into present black-white standards. This cannot be done in the case of the CBS proposal. (d) Less expensive and less complicated receivers are required. He concluded with the recommendation that the FCC dismiss the CBS petition.

Dr. Goldsmith next testified. Some of the points he mentioned that were pertinent to color TV: deficiencies in the CBS propagation tests; need for line-of-sight for uhf transmission; considerations concerning ambient light; and the advantages of the simultaneous system. He estimated a time schedule for color in which 4½ years would elapse before the FCC approves color standards.

The New York hearing ended with a request (or a challenge) from DuMont Labs. to CBS to: (1) Provide a pickup of a sporting event, for example, from Madison Square Garden, (CBS reported they cannot do this); (2) Test color reception at a number of locations where satisfactory pictures on black-white sets are now being obtained, (cooperative tests were planned later using the CBS truck and receiving equipment); and (3) Provide color pictures 12 by 16 in, with a brightness of 200 ft/l, (CBS said they cannot do this). There are other requests but the three above were the ones discussed at the hearing, which was resumed the following day at Princeton, N. J.

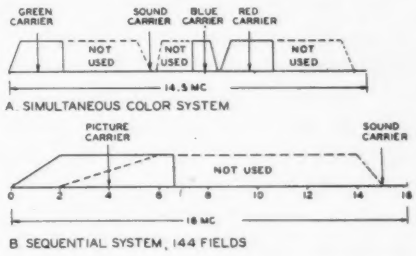


Diagram showing utilization of rf channels when color signals are transmitted by cable limited to 2.7 mc

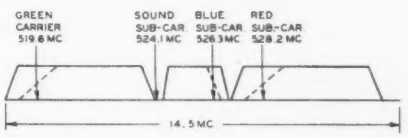


Diagram showing positions of rf carriers, sub-carriers and sidebands in simultaneous color TV Princeton demonstration

The Princeton FCC Hearings on Color Standards. RCA acted as host to the visitors and Dr. Engstrom, as master of ceremonies, did an excellent job. Following a well-laid plan he described the demonstrations as they took place. RCA has been working on color TV for some years, progressing toward a system that would have these characteristics: (a) no flicker; (b) an all-electronic system (no revolving filters); and (c) no forced obsolescence. The principle of operation of the RCA simultaneous color system, which fulfills these requirements, has been described in current technical articles. The fact that the demonstration for this hearing was a laboratory experiment was stressed. It happened that the transmission link was completed just three days before the hearing.

Diagrams reproduced on these two pages were those that were introduced by RCA as part of the testimony given before the FCC hearing in Princeton by Dr. C. B. Jolliffe, E. W. Engstrom and Ray D. Kell.

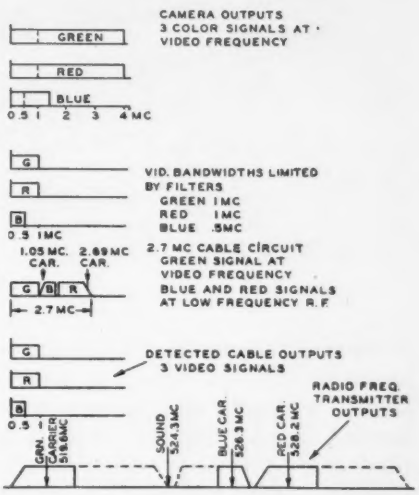


Diagram of networking method for simultaneous color TV by single 2.7 mc cable

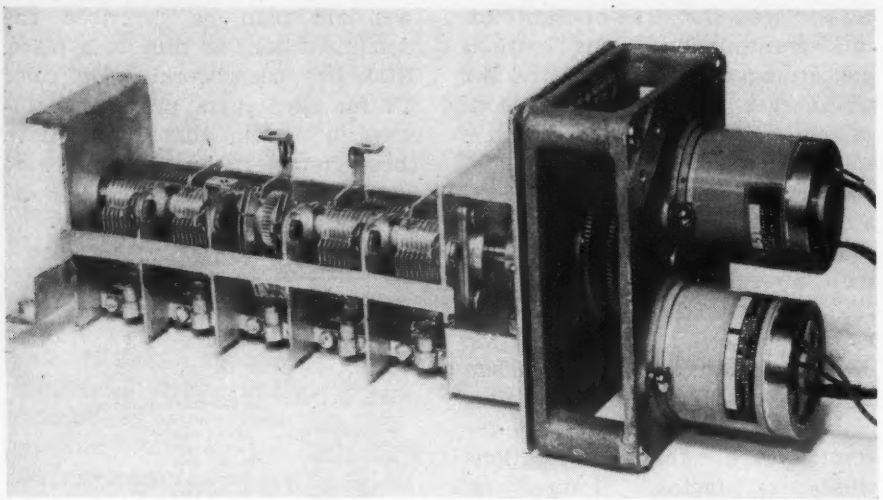
Equipment and Test Conditions. On each side of a low stage was placed one black-white receiver and one experimental color receiver. Both were of the projection type, showing pictures measuring 15 by 20 in. In the center of the stage was a table model receiver, black-white, for direct viewing of a 10 in. tube.

The demonstration opened with black-white picture broadcast from WNBT in New York and received on a folded dipole antenna 100 ft. high. This was followed by color transmission from RCA Labs. located about one-half mile away. The directive transmitting antenna, operating broadband at 520 mc was 35 ft. high. Its gain was 100. The peak power fed to it was 50 watts, hence the total radiated power was 5000 watts; but this of course was divided between the

(*Continued on page* 128)

Remote T

By JOSEPH T. McNANEY
Eclipse-Pioneer Div.,
Bendix Aviation Corp., San Diego, Cal.



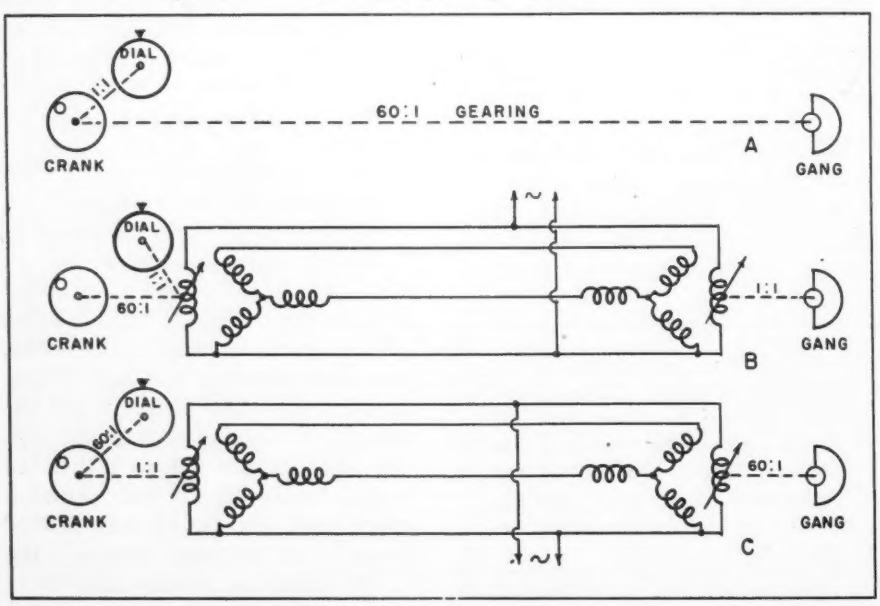
Condenser end of the remote tuning unit showing method of mounting

• In most instances radio equipment in a plane, with the exception of controls and indicators, is located some distance from the pilot's compartment which means that rf tuning has to be done by remote control. There are various reasons for this. Usually, space is at a premium in the vicinity of the control panels. The design of certain radio equipment requires the tuning components to be associated with the antenna system. In cases such as these remote tuning is an absolute necessity. Many ships contain separate compartments, some distance apart, with a crew member in each compartment. Because of this separation of the pilot and a navigator, duplicate remote tuning controls are provided in each compartment. Regardless of the reason for a separation of the tuning knob from the tuning capacitor gang of an rf unit, the usual short straight shaft will have to be replaced with another form of linkage. And as soon as departure is made from a straight mechanical shaft, the customary "feel" while tuning is more or less lost.

In practically all aircraft radio installations in the past, mechanical tach shafts have been used for remote control purposes. This type of drive connection is entirely satisfactory for tuning, provided the tach shaft lengths do not exceed a few feet and a summation of bends is not greater than 90°. When these dimensions are exceeded, tuning becomes difficult because of increased friction and backlash, particularly at low operating temperatures. Quite often preferred methods of installing radio equipment in planes have to be abandoned because of lengthy tach shaft requirements.

Considerable experimental and developmental work has been done over a period of years on various methods for tuning radio equipment electrically. Off hand, electrical tuning doesn't seem to be a very tough problem until an attempt is made to duplicate the performance of a straight stiff shaft between a control knob and gearing to the tuning gang.

Fig. 1—(A) Mechanical arrangement to be duplicated electrically; (B) substitution of autosyns for the shaft; (C) gearing needed for 180° rotation of dial



Design Considerations

Regardless of the system used for remote tuning, errors likely to be introduced between the indicator dial and the tuning gang should be kept as low as possible; in most cases not greater than ±0.25 degree. Initial misalignment should not be possible. In some of the simplest, and otherwise better systems of remote control, these difficulties are present. A few more points to be considered when attempting to design a remote tuning system are stiffness of control, smoothness of dialing, maximum condenser velocity and rf interference.

Autosyns are undoubtedly a "natural" for transmitting mechanical motion through non-mechanical links. But for rf tuning, their use is not as simple as might be thought from Fig. 1B, where a pair of autosyns is substituted for a mechanical shaft, as represented at 1A.

However, it would not be practical to drive the tuning gang with

Tuning Unit for Aircraft Radio

Methods of obtaining accuracy and reproducibility of tuning in combination with a mechanism that gives "stiffness" comparable to a shaft

an autosyn motor through 1:1 gearing, because of the large torque (5-10 in./oz.) required to turn the gang and the accuracy with which the tuning gang must be positioned with respect to the indicator dial. The torque gradient of a Type IF autosyn motor, is only .06 in./oz. per degree and therefore it would have to be geared up to run faster than the tuner.

Assuming 60:1 gearing is used as shown at 1C, a 10 in./oz. loaded gang could be rotated with autosyn displacements that are slightly less than 3°. Then, by using 1:1 gearing between the crank and the autosyn generator and 60:1 gearing between the crank and the dial, the tuner and dial could be rotated in synchronism, giving 180° with 30 turns of the crank.

The chief fault with this system is the danger of the dial getting out of step with the gang. Otherwise, it would be "stiff" enough, repeat errors would be extremely small and the weight and power consumption would not be too objectionable.

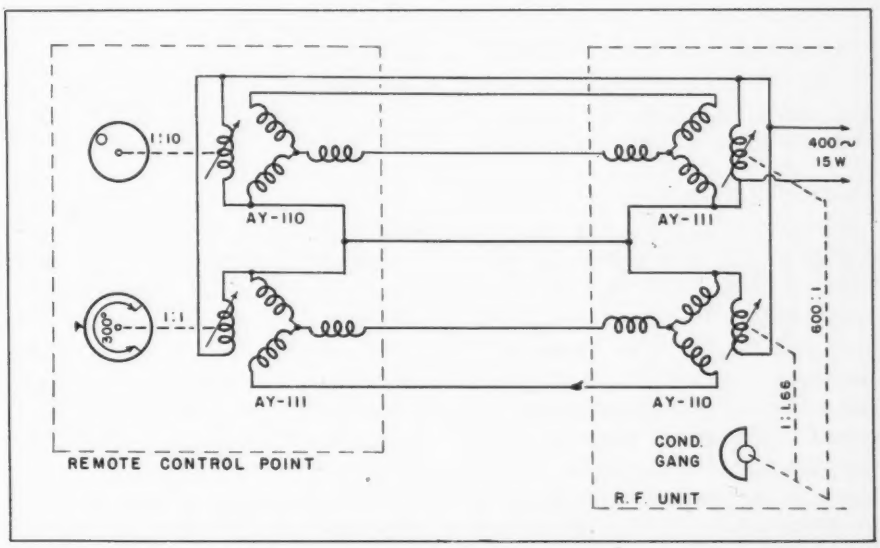
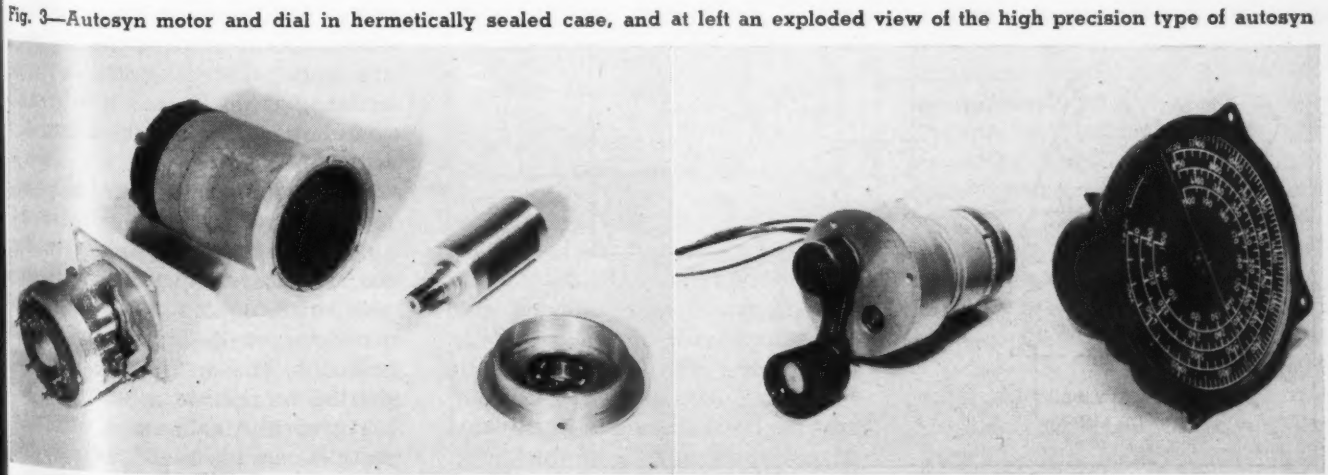


Fig. 2—System in which a generator and motor are used to drive the gang and similar units are used to repeat dial information back to the control position

The most logical approach to the solution of electrical tuning is to drive the gang as indicated in Fig. 1C and use a separate 1:1 autosyn system for transmitting shaft position data back to the control point. A system such as this could not be considered until just recently, however, because the repeat accuracies of autosyns were not good enough. For example, maximum repeat back errors in a

Fig. 3—Autosyn motor and dial in hermetically sealed case, and at left an exploded view of the high precision type of autosyn



system using an autosyn in a class similar to the Type 1F, were ± 1.5°. The weight of these units also discouraged their use, for both driving and indicating.

Eclipse-Pioneer, Division of Bendix Aviation Corp., has added high precision, light-weight miniature autosyns which are notable for their accuracy when used with precision servo control equipment. Until recently these high precision units were developed for use in synchronous controlled circuits only and were not suitable for self-synchronous indicating systems.

The newer units have made possible the development of a tuning system described here. In this system, shown schematically in Fig. 2, a generator, AY-110, is used in combination with a motor, AY-111, to drive the gang, and similar units are used to repeat dial information back to the control position.

Errors Minimized

In operation, the system requires a total of 15 watts, 400 cycles. Each autosyn weighs 4.25 oz. The indicator dial in the repeat-back system may be 3.5 in. in diameter, if necessary, which is sufficiently large for a four-band radio receiver or compass. Peak errors in the indicator system are not greater than ± .25 degree. Since this is essentially a 1:1 system, there is no danger of the dial getting out of step with the gang.

The autosyn motor and dial are supported in a hermetically sealed case. An indicator unit and an exploded view of an autosyn motor are shown in Fig. 3. The dial is extremely light and of sturdy construction in order to assure a successfully operable indicator system.

The driving autosyns are geared up to run at a higher speed than the gang shaft in order to develop the necessary driving torque. In some instances this gearing is 1200:1, in which case the crank gearing is 1:20. These ratios are based on 30 turns of the crank for 180° rotation of the gang. This indicates that when dialing rapidly, autosyn rotor velocities may rise to the order of 5,000 rpm. This may appear to be an extremely high operating speed for autosyns but these units are designed to operate very well under such conditions. By virtue of their low rotor inertia and relatively high torque, the autosyn drive system's response to rapid accelerations is exceptional. The result is that the system acts very stiff, making possible the "feel" of a direct mechanical link.

There has been a long felt need for the replacement of tach shaft methods of remote control on existing radio compasses in the field. In these particular cases the load on the gearing between a tach shaft spline and the condenser gang is usually very heavy. Therefore, the torque required of a drive motor in cases such as these have made all attempts to adapt electrical tuning very difficult. Any workable contrivance invariably has resulted in too much weight and power consumption.

One scheme which has met with considerable success, however, has a repeat-back system, similar to that described in connection with Fig. 2, and a dc step-by-step drive system. Considerable effort was devoted to the development of the transmitter and motor shown schematically in Fig. 4. It was found more desirable to go to a dc system for driving because batteries are the primary source of power. And, since considerable power is needed, the cost and weight of inverting dc to ac is eliminated.

The transmitter is a dc chopper which produces 24 successive voltage combinations on a three wire circuit for each revolution of its commutator rotor. Essentially, three phase currents are supplied to the Y-connected stator field of the step-sync motor. For each revolution of the transmitter the motor makes two complete turns, or 12 steps per revolution.

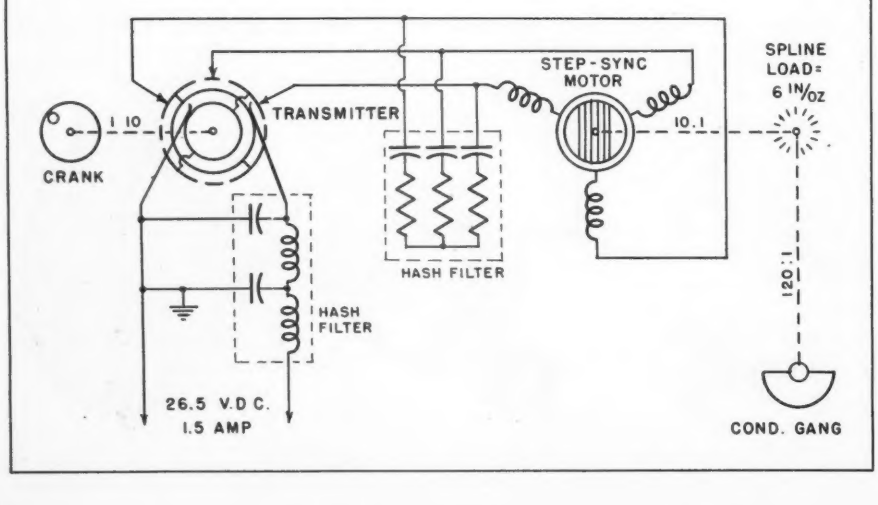
At transmitter speeds from 0 to 600 rpm, the motor responds synchronously in 30° steps. From 600 rpm to 6000 rpm transmitter speeds, the motor runs like an asychronous machine, having a constant slip of 16.6%.

Output torque and maximum speed requirements of a motor depend entirely on the frequency range of the compass and the loading at the tuning spline. For the Bendix radio compass MN-62, the spline load at —40°C is, on the average, about 6 in.-oz. Frequency coverage is from 100 kc to 1750 kc. Therefore, motor steps should not exceed 0.02° or 0.03° in order to have smooth tuning around 1750 kc, and the motor output can not be lower than 0.6 in.-oz. at 5,000 rpm.

Again referring to Fig. 4, it may be noted that 10:1 gearing is used between the motor and compass spline and 1:10 gearing between the crank and dc chopper. This combination allows the condenser gang to be rotated 180° in 7200 steps, and with 30 turns of the crank. As mentioned above, when transmitter speeds exceed 600 rpm, or when crank speeds are greater than one per second, the motor slip is 16.6%.

For this application, input power to the drive system is about 1.5 amperes at 26.5 v. dc and 6.5 watts, 400 cycles, are required for the repeat back system. The AY-111 generator of the latter system is geared to the spline through 72:1 gearing to provide a 300° dial for 180° travel. Maximum error of the complete system is ± 0.25°.

Fig. 4—Schematic showing arrangement of the dc transmitter and motor units



Oklahoma City Air Terminal showing types of antennas on control tower

Flying and landing systems chosen by PICAO for accuracy and safety

By H. GREGORY SHEA
Associate Editor, Tele-Tech

Radio Aids in Air Navigation

WHILE the choices made by the Radio Division of the Provisional International Civil Aviation Organization (PICAO) at its recent Montreal conference have been published in part, some of the devices and technics adopted for world-wide use are somewhat unfamiliar to engineers. The chart included in this issue of TELE-TECH shows the layout of some of these systems in block and schematic diagram form.

• It may be remembered that PICAO is composed of delegates from substantially all of the nations interested in world-wide aviation. These delegates viewed and tested systems exhibited by Australia, Canada, Great Britain, the United States and other nations at shows in England and America. Then they adjourned to Montreal to weigh relative merits and come to a generally acceptable decision.

Of course these decisions are not binding on any nation, but the delegates pledged themselves to use their best efforts to secure ratification by their respective countries. Naturally, therefore, these decisions are going to form the basis for the development of electronic aviation aids for the next several years. From this fact and from their own reasonableness do the decisions draw their immeasurable importance to the electronic and aviation worlds.

Many operational requirements agreed upon in Montreal can not be met by existing equipment and technics. For satisfying these, further development is needed. The schemes which are now in use or have reached an advanced stage, however, have been blocked out as reference material.

The VHF omni-directional range with superimposed voice was adopted for short distance airplane navigation. This is a substitute for the existing four-course ranges which have been installed for the use of planes over a large part of the United States. This new system provides signals over the entire 360 degrees surrounding the origin. Thus a pilot, uncertain of his position, picks up a signal anywhere and immediately knows from the pointing of the arrow on his direction meter which way he must fly to approach the range beacon. No ambiguity is possible, as when he wanders around in a present day "A" or "N" quadrant without being able to tell where he is.

The transmitter radiates from five Alford loops disposed at the center and the four corners of a square, the center loop being elevated slightly above the others. The entire array is mounted on a steel counterpoise and is surrounded by a grid of vertical wires to eliminate vertical polarization.

The center loop radiates a carrier at the chosen value around 118 mc. This is amplitude modulated by a 10 kc sub-carrier which in turn is frequency modulated by a 60 cycle wave. The pattern of this antenna is circular, and at any point the phase of the signal received from it varies in accordance with the phase of the 60 cycle modulating frequency. This signal is used as a reference phase.

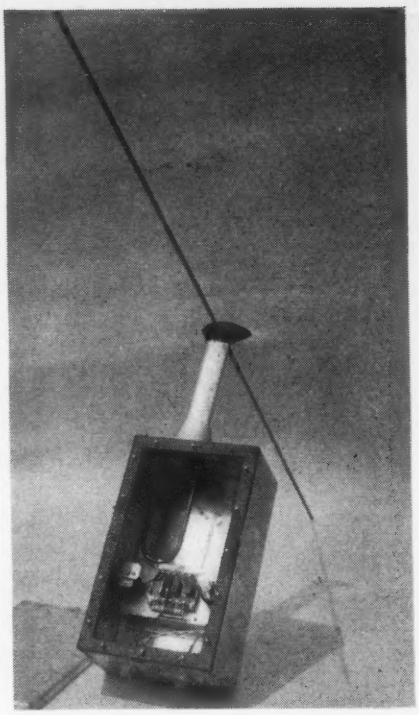
The other four loops are fed in opposed pairs, that is, one loop and its mate across the square are simultaneously fed positive and negative energy respectively. This energy is 100% amplitude modulat-

ed at a 60 cycle rate. The other pair of loops is fed the same way one quarter of a cycle (1/240th. sec.) later. The result is a 60 cycle rotating energy field.

At the receiver in the airplane this rotating energy field is received as a sine wave of energy whose phase depends on the azimuthal position of the plane with respect to the transmitter. But the plane also receives the reference signal from the center antenna of the transmitter. The two signals operate the coils of a dc selsyn type instrument called the azimuth indicator.

In addition, an azimuth selector is provided. This is fed from the reference phase channel through a phase splitting circuit. It consists of two right-angled coils supplied with energy 90 deg. out of phase, and a third coil rotatable by a control knob. The output of this device is fed through an amplifier stage to a wattmeter circuit where this controlled reference phase signal is mixed with the azimuthal phase signal to obtain plus or minus direct current indications. The output of the wattmeter circuit connects to the vertical elements of two cross pointer meters. This setup permits the pilot to select a course he wishes to fly and follow it by means of his cross pointer meter.

A zero center type meter is provided to show 180 deg. ambiguity and loss of signal indications. It operates from a separate wattmeter circuit which lags the course indicating wattmeter circuit by 90 deg. The scale is green on one side, white on the other and red in the middle. Correspondingly the azimuth selector pointer is green on one end and white on the other. The red meter area shows loss of signal.



VHF omni-range beacon course monitor

For cross pointer meter having a flag alarm to indicate loss of signal, a direct current is provided from the output of the reference channel to operate the device. It has been the practice to use a converted localizer beam receiver from the glide path—localizer instrument landing system for receiving these range signals. Voice modulation in the transmitter circuit not exceeding 40% may be used with the 10 kc reference phase modulation.

Bendix engineers operating GCA (ground controlled approach) Navy trainer

Distance Measuring Equipment

On the question of distance measuring equipment the conference agreed on the type to be standardized but when it came to the frequency to be used, the U. S. felt that it would be preferable to use about 1,000 mc whereas the conference finally adopted a frequency of about 200 mc for which Canada has developed some equipment in the past. The schematic diagram included in the chart is representative of the Canadian distance measuring equipment.

The characteristics of the equipment may be summarized as follows:

Airborne: Receiver, superheterodyne, sensitivity at rf input terminals 1.2×10^{-12} watts for a workable signal, frequency 222 mc. Bandwidth overall 2 mc. Meter presentation of distance of 0-100 miles on 0-270° scale. Distance accuracy ±1 mile at any distance.

Transmitter, push-pull triode oscillator, 200 watts peak power. 2 microsecond pulse. 200 cps recurrence frequency; frequency 202 mc.

Antenna, quarter-wave rod mounted under aircraft, T-R, with duplexer. Present overall weight of airborne equipment completely installed (including meter, antenna, cables, and fittings) is less than 22 lb.

Ground: Receiver—superheterodyne with rf amplification, sensitivity 1.0×10^{-13} watts for minimum signal giving satisfactory triggering; frequency 202 mc. Bandwidth overall 3 mc.

Transmitter, push-pull triode oscillator, 5 kilowatts peak power. 5 microsecond pulse; frequency 222 mc.

Antenna, either quarter-wave or

LaGuardia field administration building and control tower in New York. The inclination of tower sides and roof give widest vision

multi-element omni-directional, common T-R, with duplexer. Recommended height 50 ft. above ground for airways beacon and about 10 ft. for approach beacon.

Fig. 14 outlines the junctions of the airborne apparatus. The timing element is a Miller run-down circuit (V_3) which is driven by a multivibrator (V_1) through an isolating cathode follower (V_2). The output from the Miller run-down circuit (waveform shown at the anode of V_3) drives two snap circuits.

The first snap circuit (V_{10}) is driven through the lower diode (V_4) which is operated at a fixed bias so that the snap circuit will always operate at about 85 volts from the start of the run-down. This snap pulse then triggers the thyratron modulator (V_{11}) which in turn applies pulse power to the transmitting oscillator (V_{12} and V_{13}).

The upper diode (V_4), which controls the point on the rundown at which the snap circuit (V_5) will operate, is biased by the voltage at the plate of the control tube (V_6). Since the run-down is linear the time at which V_5 snaps will vary linearly with diode bias and, therefore, with the current through V_6. A meter in the plate of V_6 can accordingly be calibrated in terms of distance.

The control grid of V_6 is tied to the control grid of V_7 which is a Miller capacity amplifier. V_6 has then, in effect, a capacity of about 400 microfarads in its grid circuit which, together with the grid resistance, gives a time constant of several minutes.

The blocking oscillators, V_8 and V_9, produce strobe pulses of 5 microseconds and 10 microseconds respectively, when triggered by the snap, V_5, and these pulses are applied to the screens of the video amplifier tubes V_{15} and V_{14} respectively. The control grids of V_{15} and V_{14} are fed in parallel from the receiver video output.

If a signal occurs within *both* strobes, an integrated negative voltage will appear on the grids of V_6 and V_7, due to the output of V_{15} acting through the diode V_{16}. This in turn will increase the positive bias on the snap circuit, V_4-V_5, so that the snap time delay of V_5 will be reduced and the two strobe pulses will move towards minimum distance.

A positive voltage is produced by the strobed video from V_{14} but it is overridden by the negative output from V_{15} as long as the signal occurs within the 5 microsecond strobe. However, if the signal occurs beyond the end of the narrow strobe but within the wide strobe, the positive voltage alone will be applied to V_6 and V_7 and the strobes will move towards maximum range. (The waveforms for this case are shown in sequence at the upper right of Fig. 14).

If a signal occurs anywhere within the 10 microsecond strobe the strobe will move until the trailing edge of the 5 microsecond strobe lies within the signal pulse. The strobes therefore lock on the signal and follow it.

(*Continued on page* 124)

Guide Beam Control Technic for V-2 Rockets

By G. HAUSZ, Electronics Laboratory Div., General Electric Co., Schenectady, N. Y.

Basic principles and engineering details of radio equipment permitting accuracy within tens of yards at 100-mile ranges

WHEN four tons of hot metal and explosive are careening through space at one mile a second toward a target several hundred miles away—far out of sight below the horizon—the problems of guiding this missile to pinpoint accuracy are monumental. Starting in 1932, first hundreds, then thousands of topnotch German scientists spent years on this and other problems which culminated in the V-2 rocket. In a previous article it was told how they solved one of the problems—the measurement of velocity. Thus, when the rocket power plant was cut off, the missile had the proper angle of elevation and proper velocity to continue by ballistic principles to the range desired. In this article are described the means used to minimize deviations from the vertical plane through the target and launching point, ie: to guide the missile in a straight line.*

• On a majority of operational V-2 firings, no radio control was used because of shortages of electronic components, lack of suitably trained personnel, and a fear of jamming of the radio signals by the Allies. For these firings, the V-2 stood vertically on its launching platform and was rotated until precision surveying instruments indicated that the gyro control equipment in the rocket was carefully oriented along the designed line of flight.

After this was done, the accuracy in "line" was determined by the errors in this adjustment and the errors caused by gyro and missile performance. During the powered portion of the flight, the gyro was subject to severe conditions of vibration and to prolonged accelerations of as much as five times gravity. For this period, the gyro must depend on its "memory," or stored angular momentum, to retain the proper direction. Due to bearing friction and other imperfections, the resulting dispersion from the target averaged ±2.0 miles (50% of the rounds were within these limits).

To improve this accuracy, radio means of automatic control were used on such spot targets as Antwerp which gave a dispersion in line of only ±0.8 miles. The code name for this equipment was "Viktoria" but it was more familiarly known as the "Leitstrahl" (guide beam). A young Doctor of Engineering, Ernst Steinhoff, developed this equipment as a blind approach for aircraft in the mid '30's. Therefore, it was only natural that when he joined the group of scientists developing the V-2, he, as the

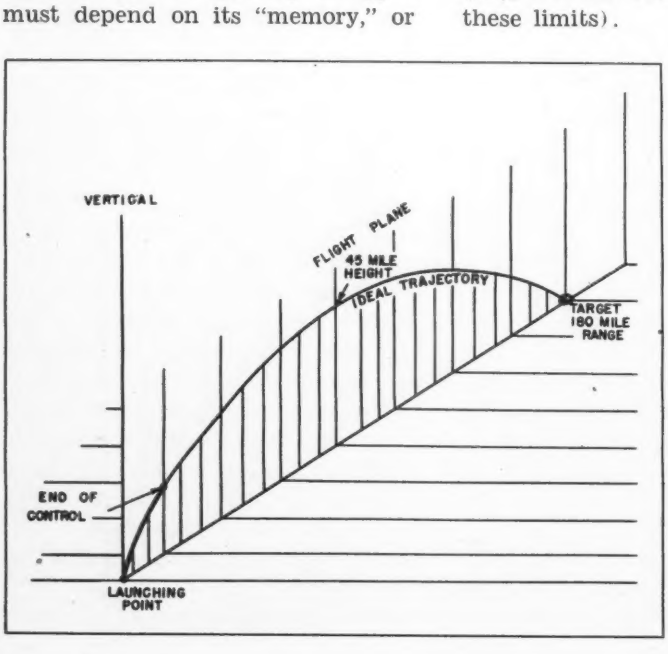
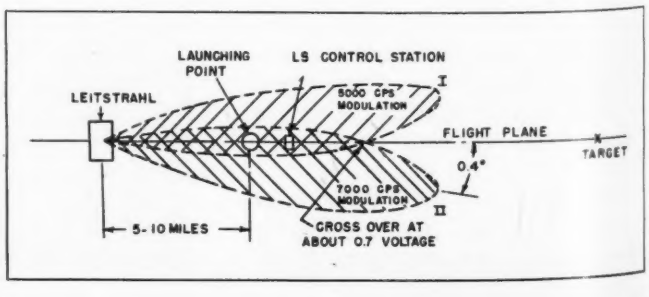


Fig. 1 (Left)—Desired trajectory of missile showing point of control cut-off. Fig. 2—Guide beam pattern produced by "Leitstrahl"



*McAllister, "Measuring Velocity of V-2 Rockets by Doppler Effect," Tele-Tech, Feb. 1947, p. 56.

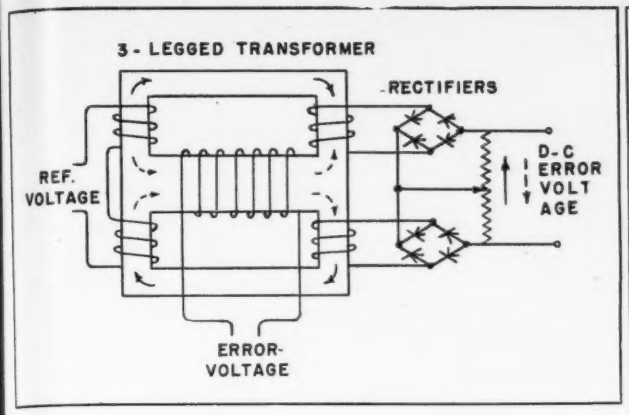


Fig. 4—Method of combining error and reference voltages to obtain dc signals

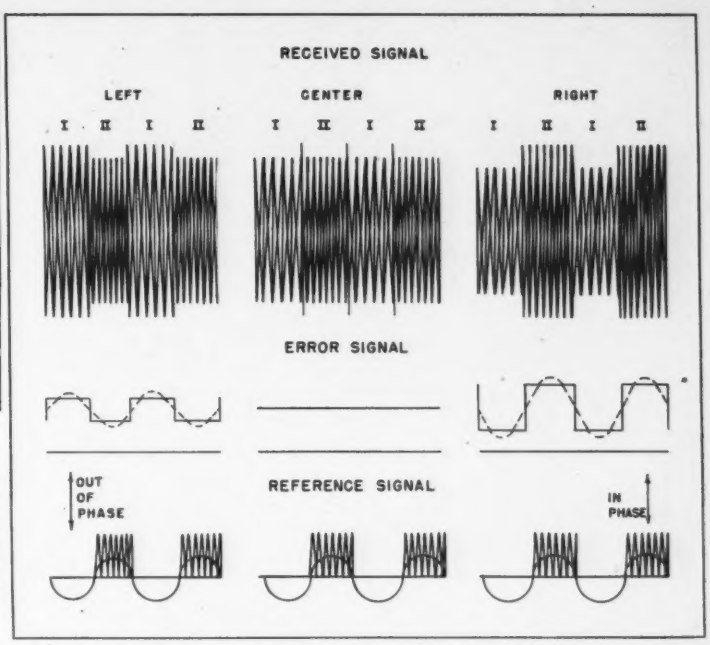


Fig. 3—(Right) —Character of signals received at missile for on-target and off-target position

leader of the control section, should turn to the well-established principles of this system.

The basic principles of the Leitstrahl are similar to the familiar U. S. radio range in which two overlapping radio beams give a pilot either an A or an N signal in Morse code if he deviates from a mid line. In the German Leitstrahl (LS) System, Fig. 2, two narrow beams are switched on alternately, each for 1/100 second. Instead of Morse code, audio modulation is used on the beam. When it is in the right hand position, 7000-cycle-per-second modulation is used; in the left hand position, 5000 cps is used.

Control Signals

The types of signal that are received at the missile when it is "on target" or to the right or left of the true course are shown in Fig. 3. When it is to the left of true course, the amplitude of the signal is greatest when the modulation frequency is 5000 cps. When it is to the right of true course, the amplitude of the signal is greatest when the modulation is 7000 cps. Only on the line defining the true course is the amplitude of signal constant.

This signal is detected and the resulting envelope is passed through a 50 cycle filter. The circuitry in the missile then forms an approximately sinusoidal wave whose amplitude is proportional to the magnitude of the deviation from the true line of flight.

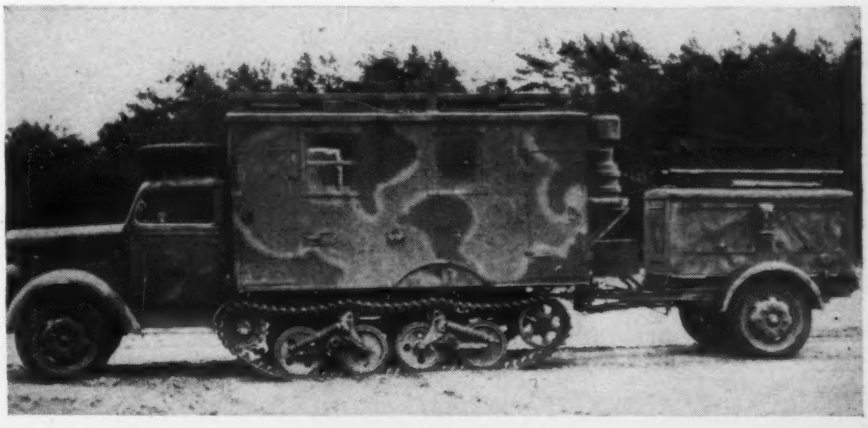
To use this voltage, effectively, a reference voltage of the same frequency (50 cps) but of constant phase must be provided. This is obtained in a separate amplification channel which includes a filter that passes 7000 cps and rejects 5000 cps. The error voltage is in phase with the output of this channel for deviations to the right of target and is out of phase for deviations to the left. Combination of the two signals in the manner shown in Fig. 4 results in a dc voltage output which is positive or negative for errors to the right or left respectively. This signal is fed into the missile control circuits to cause automatic return of the missile to its true course.

Control continues only during the sixty seconds of powered flight. Beyond this time there is no jet, and aerodynamic forces are too small for control, so the missile coasts as a free body part of the time substantially in a vacuum.

The ground equipment is fully mobile and can be set up within several hours. In convoy the equipment consists of two half-tracks of the type shown in Fig. 5. These, known as the transmitter-wagon and the apparatus-wagon, pull three small two-wheeled trailers, which comprise the power supply and the two antennas, one of which is shown in Fig. 6. The apparatus wagon contains chiefly cables and spare parts.

In the transmitter-wagon, the arrangement of the chief apparatus is shown in Fig. 7. In the crystal oscillator A, any one of ten crystals may be selected by switch to match the receiver frequency of the missile. This is a precaution against jamming. Normally, only three crystals are used at one site, as major adjustments of antenna, etc., are needed to use all ten. The output circuit of the crystal oscillator is tuned to double the crystal fre-

Fig. 5—Ground equipment, contained in two half-tracks, can be set up in few hours



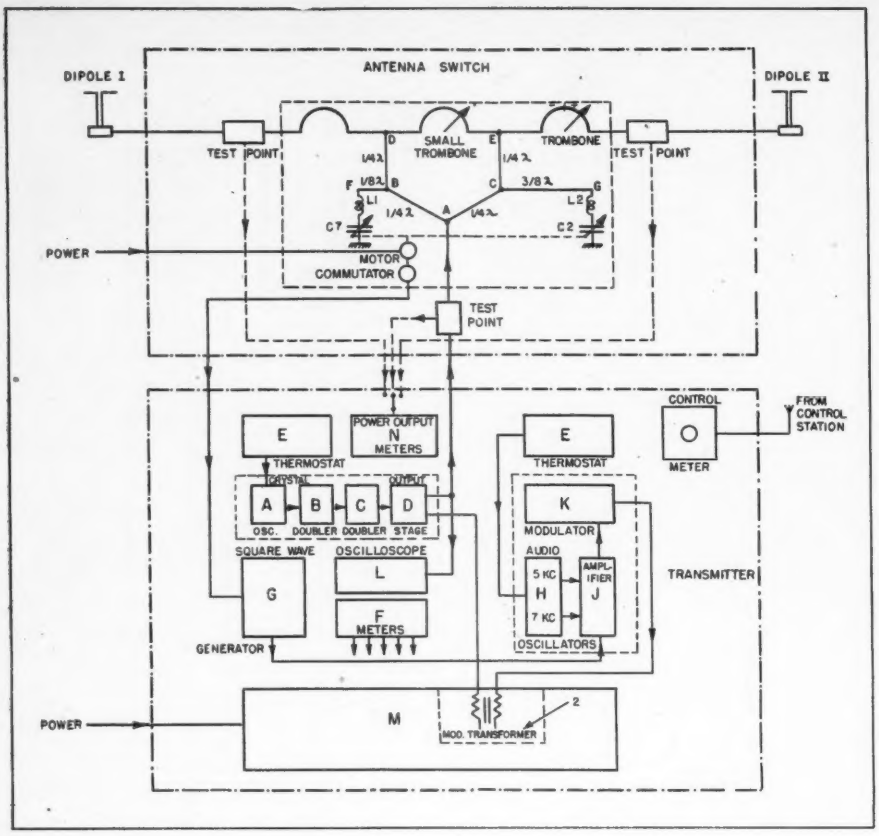


Fig. 7—Schematic of arrangement of equipment carried in the transmitter wagon

quency and two more doublers are used—B and C—to deliver eight times the crystal frequency to power amplifier D. The power amplifier consists of two LS 1500 filamentary triodes in push-pull. Its output is 4 kw in the 42-64 mc band. An anode voltage of 2000 volts ±1200 volts of plate modulation is used.

Beam Shifter

Two audio oscillators of the resistance-capacitance type are included at H. The motor which operates the 50-cycle beam-shifting scheme in the antenna, as will be described shortly, produces a 50-cycle square wave on a commutator. Push-pull amplifier G delivers two outputs which are alternately zero and —250 volts. The high negative voltages are used to bias alternately audio frequency amplifiers in J so that the 5000 and 7000 cycle tones are delivered successively to the modulator K. Both the crystal oscillator and the audio oscillators are thermostatically controlled by apparatus at E.

Miscellaneous apparatus included in the transmitter console are the power rectifier M, meters at F for measuring important voltages and current, an oscilloscope at L for inspection of audio voltages and modulation, meters at N for tuning the output circuits for maximum power, and a meter at O connected to the control station to be described later.

The key to the accuracy of the Leitstrahl is the antenna assembly. This consists of two horizontal halfwave dipoles which are set up colinearly and separated by 220 yards. The pattern of a single dipole is a figure eight as shown by the dotted envelope of Fig. 8.

When two dipoles separated by about thirty-five wavelengths are fed in phase, directions of reinforcement and cancellation of the radiation from the two will alternate every 0.8 degrees as indicated by the narrow lobes of Fig. 8. By changing the relative phase in which the two dipoles are fed, the many narrow beams are made to move to the right or left.

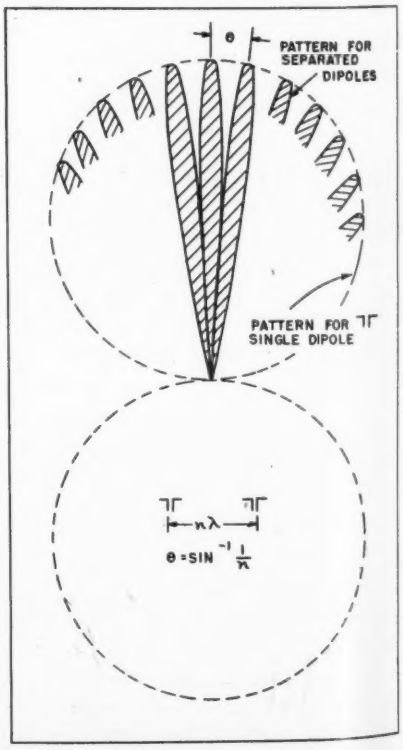
Midway between the two antennas is the antenna switching network of Fig. 7. Two alternative paths exist for transferring power from the transmitter to the antennas. These are ABD and ACE. It can be seen that if the path ABD is used the left-hand antenna will lead the right hand one in phase. Similarly, if ACE is used the right antenna will lead in phase. In switching from ACE to ABD, the change in relative phase is dependent on twice distance DE. Distance DE is made about one quarterwave so in the neighborhood of the desired line the radiation pattern is as shown in Fig. 2 for the two feed paths.

Antenna Switching

Switching is done not by mechanically opening and closing contacts but by two rotating capacitors, C_1 and C_2. The form of these capacitors is shown in Fig. 9. The narrow rotor width causes the capacitance variation with time to be substantially a square wave between a maximum and a minimum value.

The inductance values and the lengths of BF and CG (Fig. 7) are chosen so that the impedance values looking into BF and CG are respectively an open-circuit and a short-circuit for the maximum value of capacitance and conversely a short-circuit and an open-circuit for the minimum value of capacitance. In the former case all the power goes through ABD and in the latter case through ACE. A short-circuit at B or C looks like an open-circuit at a point one-

Fig. 8—Pattern for two separated dipoles



quarterwave away—i.e., A, D, or E —hence no power is wasted in the shortcircuited branch.

Because of the many narrow lobes caused by this simple antenna structure, it is essential that the missile be prevented from starting in the wrong lobe. To do this the ground station is mounted some five to ten miles behind the missile launching point where the desired lobe is then sufficiently wide to make jumping to the wrong lobe unlikely.

To obtain the maximum in accuracy without imposing unduly rigorous conditions in setting up the antennas, it is customary to have a control station located near the launching point. This station consists of a high antenna and a replica of the equipment that goes in the missile. The line between this station and the point midway between the transmitting antennas is very accurately surveyed and made to be the desired flight line. The dc error signal received at this station is amplified and transmitted by cable back to zero-center meter 0 in the transmitter-wagon. It is there adjusted manually to be ex-

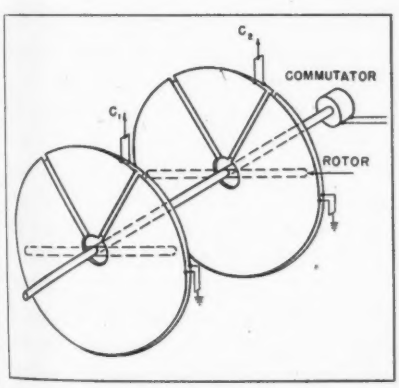


Fig. 9—Antenna switching to produce beam is done with this rotating capacitor

actly zero at all times by means of the trombone-like section of transmission line (Fig. 7) which rotates the lobe pattern as needed by adjusting relative phase.

Missileborne Equipment

The missileborne equipment naturally must be compact and light in weight. It consists of a die-cast chassis with provision for attaching six sub-chassis. These are shown in block diagram form in Fig. 10. An antenna in the tail of the V-2 delivers the rf to the first sub-chassis, a receiver with one rf

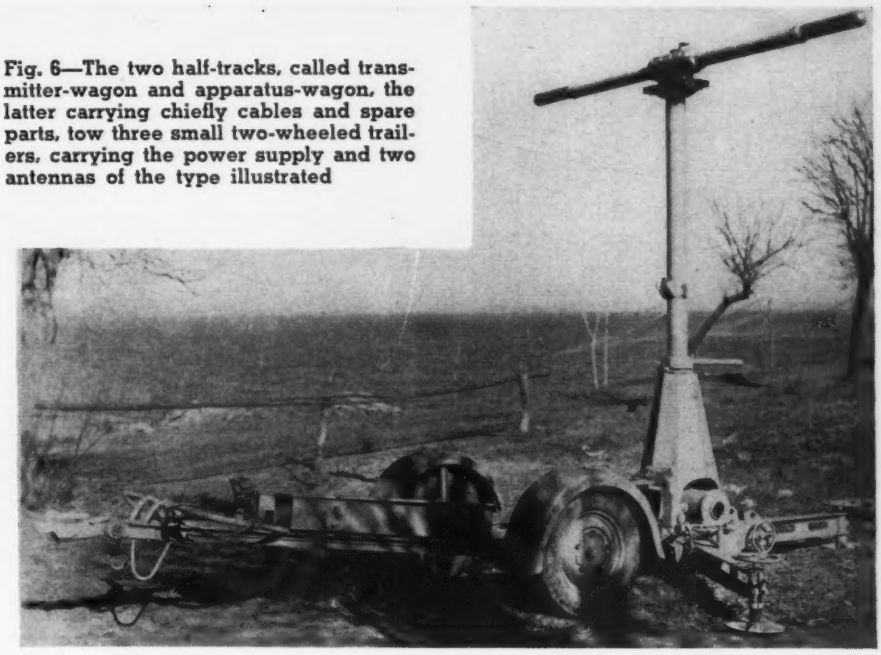


Fig. 6—The two half-tracks, called transmitter-wagon and apparatus-wagon, the latter carrying chiefly cables and spare parts, tow three small two-wheeled trailers, carrying the power supply and two antennas of the type illustrated

stage, a triode-heptode mixer with crystal controlled local oscillator, and three double-tuned IF amplifiers. To cover production tolerances in crystals the IF band width is about 40 kc. Corresponding to the ten transmitter frequencies, there are ten crystals for local oscillators. The receiver portion of the apparatus is easily changed to minimize the danger of jamming, and each different frequency has a different code name.

The last IF stage is a duo-diode-pentode. One diode is used for automatic volume control (AVC). Not only is AVC voltage delivered to the rf and first two IF tubes, but a small amount of it goes to the first audio amplifier, causing the output to be almost completely independent of input field strength over a wide range. The other diode circuit contains two transformers, one tuned to 50 cycles, the other tuned to 7000 cycles. The outputs of these transformers go to the next sub-chassis.

In sub-chassis II, the 50-cycle signal undergoes two stages of amplification. For the 7000-cycle signal a duo-diode-pentode is used. One diode gives strong limiting in the grid circuit. A 7000-cycle tuned circuit in the plate couples to the other diode, which functions as third detector. The voltage across a 50-cycle tuned circuit in this diode circuit is amplified to provide the reference signal shown in Fig. 3.

In sub-chassis III the reference and error signal voltages are combined in a three-legged transformer (Fig. 4) to give their sum and their difference in two sets of secondary windings. Each set of secondary winding voltages is rectified and combined to give a dc signal of polarity and magnitude proportional to the error in line of flight. One of these two dc signals is passed through a rate network to give an output that favors the rate of change of error signal over the error signal by about 10:1. In correcting any error by causing the missile to turn, a network of this type tends to prevent overshooting.

Error Corrections

The other dc signal is passed into an integrating network with a time constant of thirty seconds or more. Its purpose is to correct for constant error sources such as a steady cross wind, or an error in the initial gyro setting. Both dc signals are combined in a twin-triode modulator on sub-chassis IV. In this a 500-cps voltage injected into the cathode lead causes a 500-cps output error signal unless the bias on both grids is the same. The control circuits of the missile require such a 500-cps signal.

If the errors caused by deviations from the proper line are truly random, they will be to the right as often as to the left, and because of the long time-constant on the integrator network, the net voltage

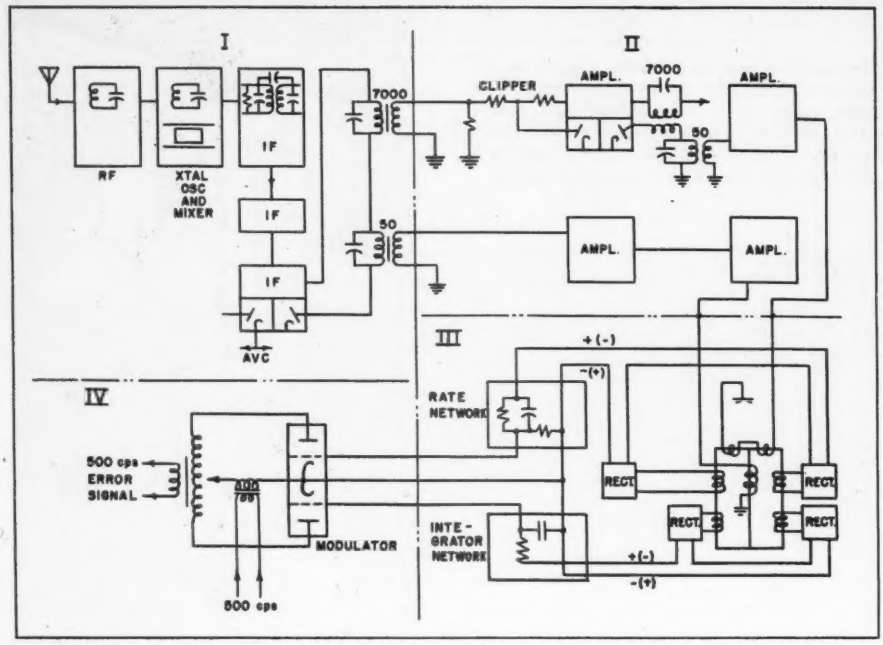


Fig. 10—Missile-borne equipment is carried on a die-cast chassis with provision for mounting six sub-chasses, illustrated here in block diagram

output of this network will not differ substantially from zero. Then the 500-cps output error signal will only depend on the output from the rate network. Now, if a strong wind or wrong gyro setting tends to make the error in line of flight always to one side, although the rate network output would tend to bring it back, the most probable final direction is shifted to this side. However, since the integrator network input has one polarity more frequently than the other in this case, it gradually builds up a non-zero output of just the proper amount to compensate for such constant error sources. The dispersion is again shifted to a position centered about the desired line.

Automatic Corrections

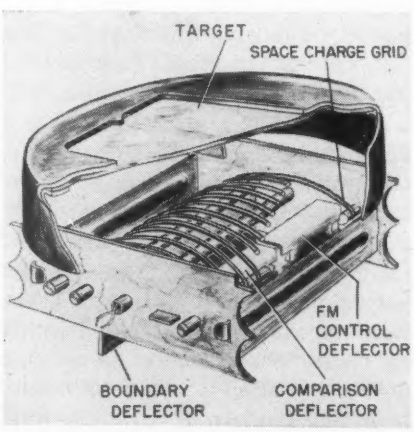
Also contained in sub-chassis IV is a ratchet-driven cam which changes various gains and time-constants as a function of time. The speed, distance, and air-density conditions under which the V2 operates change over such a wide range that this measure is required for stability. In another sub-chassis is the power supply deriving dc anode voltage from the master 500-cps supply of the missile. The last sub-chassis is blank because design changes permitted putting into five units what originally occupied six.

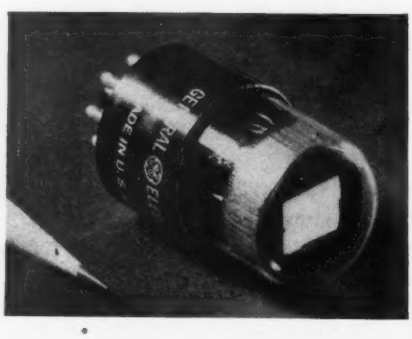
When a system such as described is used with aircraft, it permits their control to within tens of yards at 100-mile ranges. However, on the V-2, where control is used for only the first minute of a five minute flight, much better accuracies were expected than were obtained. That the reason was a slight tendency of the flight path toward oscillation near the end of the control period is shown by the fact that the dispersion obtained was double-humped and not Gaussian. Each of the humps was only 0.3 miles wide. But considering the low frequency used, the accuracies obtained are remarkable. This band of frequencies was used chiefly because of availability of components and techniques in the early war years.

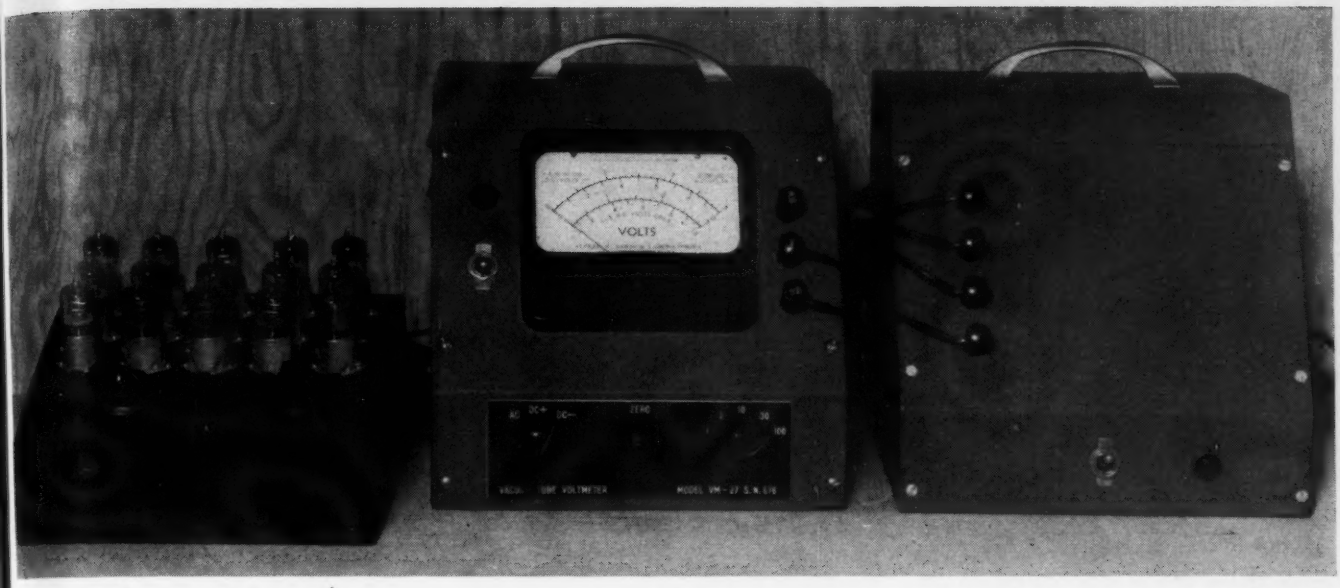
There was a trend toward higher frequencies and a similar system had already been developed by the end of the war for 500 mc. This was called the "Leitlinie" or guideline to indicate even better accuracy and sensitivity than the guide-beam or Leitstrahl. With progress in the direction of higher frequencies, directive antennas, narrower lobes, more sensitive receivers, more rapidly responsive error circuits, this system offers continued promise in the field of precision control of airplanes and missiles.

Block Tuning Indicator Tube for FM

Developed to simplify the problem of precise tuning of FM receivers and also adaptable for service as a null-indicator in bridge circuits and test equipment, 6AL7-GT electron-ray indicator tube has a translucent screen, consisting of a glass disc, as a target on which the fluorescent material is deposited. The fluorescent pattern is viewed through the screen. This construction makes it possible to locate all other tube electrodes such as heater, cathode, and deflecting plates behind the target and out of sight. Masking the center of the screen, necessary in previous indicators, is thereby eliminated. Color patterns in the form of "blocks" are formed on the screen during FM tuning. When two halves of the block pattern are aligned and of the same size, the station is precisely tuned in. By tying all deflection electrodes together and applying AVC to them, the control also can be used for AM tuning. Proper tuning in this case is indicated by a fluorescent band of light reaching its minimum width. By controlling the bias of a space charge grid, target current and pattern brightness can be affected. The tube is manufactured by the Electronics Dept., General Electric Co., Thompson Road, Syracuse, N. Y.







In order to stabilize emission and thus insure continued accuracy of the instrument, tubes are aged before they are finally calibrated

Vacuum Tube Voltmeter Design Problems

By ALFRED W. BARBER
3408 Francis Lewis Blvd., Flushing, N. Y.

Advanced circuits and quality control combine to extend the range, accuracy and stability of a new instrument for ac, dc, and rf measurements

• A vacuum-tube voltmeter cannot be applied indiscriminately to measurements where unusual conditions are encountered until its operating characteristics are carefully considered. This article deals with the type of instrument that handles both dc and ac values, giving a response in the latter case in accordance with peak ac values. For convenience such an instrument is usually calibrated in rms values, based on sinusoidal waveform assumptions.

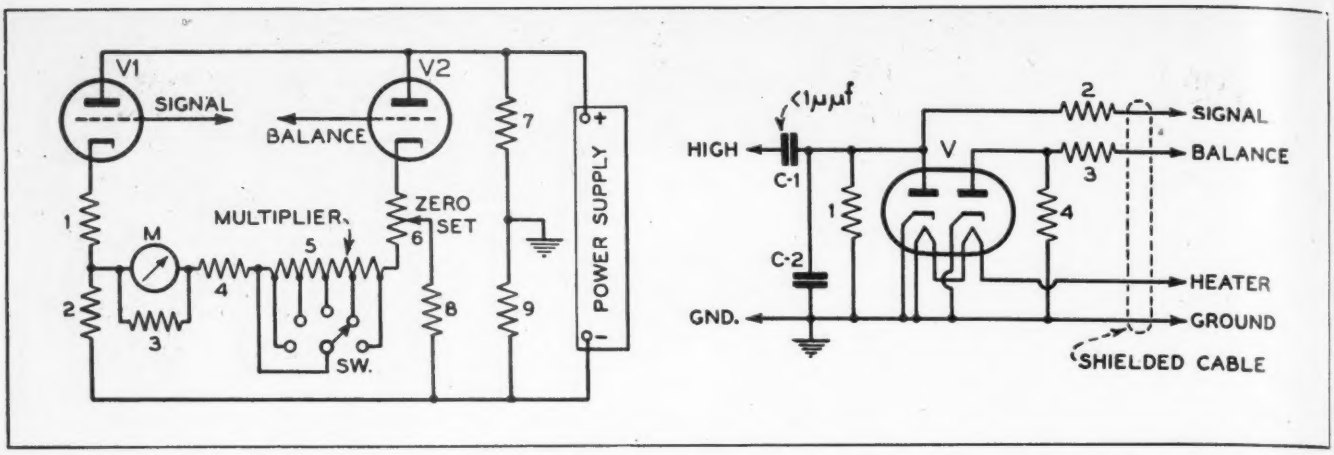
Diodes may be operated to provide either square-law, average or peak response. However, the square-law region, confined to the range below about 0.1 volt, is not useful in a wide-range instrument, since (at least for high frequency operation) a satisfactory input attenuator is not easy to make. However, if the diode has a large shunt resistor, peak response, high input impedance, wide frequency range and wide voltage range will result. Since the majority of measurements are made with essentially sine wave input, the meter can be calibrated at either 0.707 of peak (average) or else the rms value, as most convenient.

Basic Requirements

In the selection of an instrument for either general or particular applications certain fundamental characteristics must be considered: The accuracy of the scale readings in each range, stability (freedom from short time drifting and long time aging), sensitivity, input impedance (at dc, low ac and radio frequencies), number of ranges, and the stated overall accuracy at the maximum scale reading in each range. In addition, other characteristics, which are self-evident by inspection or by simple tests, must be considered, such as readability, constancy of the zero setting on all ranges, scale linearity, etc.

In reviewing the characteristics of a voltmeter, probably the first thing that comes to mind is the total voltage range and particularly how far the lower end has been extended downward.

A maximum sensitivity (considering the diode rectifier and dc amplifier type of vacuum-tube voltmeter) of the order of 1 volt full scale has been commonly adopted. Somewhat greater sensitivity actually is possible, either at additional cost or at a sacrifice in performance. The problem of increasing sensitivity concerns both the diode rectifier and the dc amplifier.



Simplified circuit of the vacuum tube bridge at the left, and at the right the circuit arrangement that is used in the diode probe

The efficiency with which a rectifier performs is determined by its ratio of conduction in the positive and negative directions and (particularly at low voltages) the sharpness of its change in conduction around zero. At 1 volt (ac) most conventional diodes, such as the 6H6 and 6AL5, produce slightly more than 1 volt of dc. At lower levels this conversion factor decreases rapidly so that at 0.1 volt (ac) the dc drops to approximately 0.04 volt and below this rapidly becomes vanishingly small. Furthermore, the variation in sensitivity between different rectifier tubes becomes greater as the voltage is reduced. The change in initial (or contact) voltage in the diode also becomes an increasingly large percentage of the rectified voltage, eventually causing a serious drift problem.

Balancing Circuit

As has been known for some years,* the matter of getting stability in such vacuum tube circuits is accomplished by providing a balancing circuit, containing a tube whose characteristics are as near those of the active tube as possible, to neutralize all conditions of supply voltage variations, temperature, aging, etc. The signal to be measured is applied to only one of the tubes in the balanced circuit. In this voltmeter the indicating meter (in series with a multiplier resistor) is connected between cathodes of the two tubes.

If it were possible to provide 100% degeneration for both tubes the signal tube cathode would exactly follow the signal on the grid and the balancing tube cathode voltage would remain constant. Actually, the degeneration is less than 100% with the result that in supplying current to the meter the signal tube cathode voltage lags behind the grid voltage and the balancing tube cathode voltage changes an equal amount in the opposite direction. These two voltage shifts must be subtracted from the signal voltage to find the true driving voltage across the meter and its multiplier.

This loss in driving voltage is directly proportional to the current through the meter and inversely proportional to the dynamic mutual conductance of the dc amplifier tubes at the actual point of operation. This voltage drop being one of the factors limiting sensitivity explains the importance of selecting a tube for the dc amplifier which has high mutual conductance, particularly at less-than-rated plate current.

Another point should be kept in mind. The maximum overload current which can pass through the meter depends upon the point of operation of the dc amplifier tubes. As the sensitivity is increased either by increasing the meter sensitivity or by increasing the dc amplifier plate current, the danger of meter burn-out is increased.

The standard voltmeter model utilizes 6J5 tubes in the dc amplifier and a 200 microampere meter. The tubes are operated at 4 ma plate current and have a higher mutual conductance at this current than most other tubes. The maximum current which they will pass through the meter in series with the lowest multiplier resistor is 4 milliamperes which is the worst possible condition. Since only one meter burn-out has been reported during the past three years a safe design seems evident.

Tube Requirements

Although the dc amplifier uses a highly degenerative circuit, the meter deflection at 1 volt dc starts to vary with the mutual conductance of the tubes. At lower dc input levels increasingly more stable mutual conductance characteristics are required for a given accuracy. In order to go below about 0.5 volt (ac or dc) either tubes having greater mutual conductance must be used, or they must be operated at higher current levels, or a more sensitive meter is required. The 6J6 tube offers some increase in mutual conductance and it may be operated at a somewhat higher current, but care must be taken to avoid an increased and troublesome grid current. However, by selecting a meter with considerably greater than 200 microamperes sensitivity, a laboratory model VTVM has been produced having a full scale sensitivity of 0.1 volt ac and 0.05 volt dc.

When a signal is applied to the grid of the dc amplifier signal tube, the cathode voltage follows it exactly except for the drop described above. As an example, this drop may be 0.1 volt per tube at full scale or a total of 0.2 volt. On the higher voltage ranges the cathode voltage is almost exactly equal to the grid voltage.

When a negative voltage is applied to the grid the cathode goes

*Patent—Alfred W. Barber, 2,039,267, dated Apr. 28, 1936.

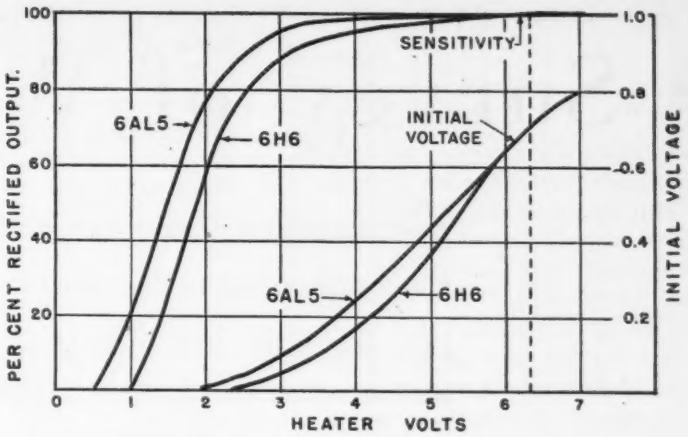
negative and approaches the negative voltage of the power supply as a limit. At 100 volts ac, the dc amplifier receives 140 volts, hence the negative voltage for the cathode return must be greater than 140 volts. The model VM-27 is provided with 200 volts from the power line supply, giving ample margin for low line voltages.

Likewise when a positive voltage is applied, the corresponding cathode goes positive and several related effects take place. At + 100 volts, the cathode is drawing 50% more current, which increases the grid current. Since the cathode voltage is approaching the plate voltage, both the net plate voltage and the net bias are decreasing—both tending to increase grid current. If the plate voltage is too low, the net grid bias that permits cathode current flow will cause the tube to operate at a point where a rapid increase in grid current takes place and the input resistance to the voltmeter will fall rapidly. It has been found that a plate voltage of 200 is required to allow application of + 100 volts without unduly increasing grid current. Thus, the circuit of the VM-27 is supplied with + 200 volts to the dc amplifier and — 200 volts to the cathode returns.

This design permits the application of the full diode output on the

Instrument designed for 500 kc to 500 mc

grid of the amplifier. High accuracy and interchangeability of probe tubes are achieved thereby, since the calibration does not depend on the resistance of an attenuator that must have an impedance of many megohms. All range multiplication is done by selecting



Comparison of rectifier efficiency and contact potential for two types of diodes

a precision wire-wound resistor connected in series with the meter.

Although indicating meters are rated at 2% accuracy by the manufacturer, these voltmeters can be individually calibrated to better than 1% by making two adjustments: one on the 1-volt range, correcting for variations in meter resistance, and the other on the 100-volt range compensating for the meter sensitivity. Experience gained over a number of years indicates that this procedure results in an accuracy of the order of 1% (or better).

Aging Tubes

Stability is usually the most important characteristic of a good vacuum-tube voltmeter. Voltmeters must utilize wire-wound multiplier resistors and other high-grade components so that any remaining instability must be due to changes within the tubes and to the line voltage. The most essential procedure, therefore, is proper aging of the input rectifier and dc amplifier. In tests after aging, those which show low drift characteristics are matched, using the test setup illustrated, for use in pairs to minimize the effects of line voltage variations. With such tubes, warm-up of the voltmeter is practically complete in two minutes. Replacement tubes having the same characteristics are always available.

Another consideration is that the circuit of the voltmeter should provide a constant zero setting for all ranges. The zero shift may best be described in terms of voltage: it can be expected that the zero will not drift more than 0.02 volt during the first hour of operation if accurately set, and considerably less thereafter, regardless of the range used. The zero setting properly made on the 1-volt range will hold for all higher ranges. To do this (for ac operation) the probe terminals should be shorted or precautions taken so that no stray voltage is picked up by the "high" terminal. On dc the problem is not quite so simple, since grid current in the amplifier tubes may produce a bias of up to 0.03 volt through the 7 megohm internal resistance.

If measurements are to be made on a low impedance circuit (that is, 1 megohm or less) the dc terminals should be shorted when making the zero adjustment. With more than 1 megohm the zero adjustment should be made with a shunt which approximates the actual circuit under test. However, with inputs of one or more volts this precaution is unnecessary. In any case, no error will be caused by the grid current if zero adjustment is made with the meter connected across the circuit to be measured in the absence of any voltage. Regardless of how the zero setting is made, with properly tested tubes the maximum possible error will be 0.02 to 0.03 volt, since tubes showing more grid current than this after aging are discarded.

After tubes have been aged to the point where grid current is at a minimum, change in the activity of the cathodes of the dc amplifier tubes is the major cause of drift. Therefore, it has been found essential to discard tubes showing a drift due to cathode change of more than 0.02 volt during the first hour of operation and 0.01 volt per hour afterward. Zero shift due to line voltage changes will not exist with

(*Continued on page* 118)

Survey of Wide Reading

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

Ion Current Intensity Modulated by Sound Waves*

Several years of investigations are said to have led to a source of positive ions that operates satisfactorily when exposed to air, i.e., without shielding envelope; the current intensity of the ion stream can be directly modulated by sound waves. Because of its comparatively

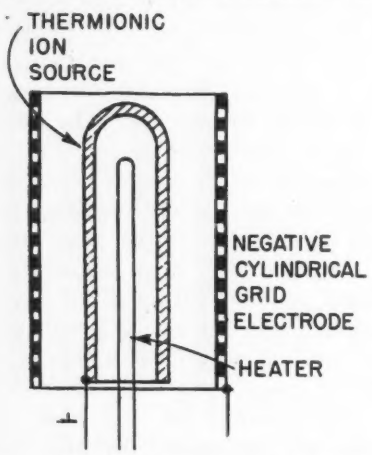


Fig. 1—Positive ion source and surrounding negatively-biased electrode; no shielding envelope is provided

large surface, platinum sponge is mentioned as suitable source material for platinum ions. The cylindrical source (Fig. 1), is surrounded by a negatively-biased cylindrical electrode.

The author claims to have constructed an ion source having a surface of 250 mm², which, at an applied voltage of several hundred volts, supplies a continuous current of the order of milliamperes over a long period of time. The curves in Fig. 2 represent measured values of this positive ion current obtained from a 50 mm² surface surrounded by air at atmospheric pressure; t indicates the source temperature in centigrades. The loss of weight of the source under the influence of an applied voltage and due to the positive ions leaving the emitting surface was also established by experiments.

It is suggested that a variation in air pressure influences the amount of ions emitted by the source and also changes the "resistance" of the air to the ions traversing the space between the emitter and the negatively-biased collecting electrode. Measurements of the ion current at various air pressures resulted in the full-line curve, shown in Fig. 3, illustrating dependence of the current intensity on the pressure. The dotted curve takes care of the temperature variation with pressure, correcting for constant temperature.

This current-intensity pressure relation permits, it is argued, modulation of the current intensity by a pressure wave, or conversion of sound waves into electric waves,

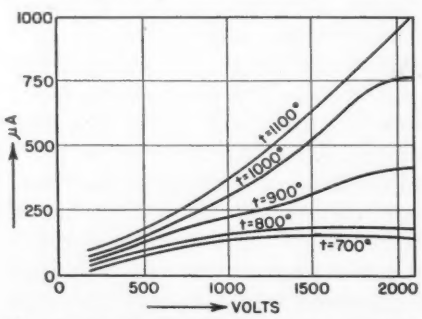


Fig. 2—Intensity of positive ion current as function of applied voltage with temperature as parameter; measurements made at atmospheric pressure

suggesting a "thermionic microphone." An experiment to test the possibility of the "thermionic microphone" is reported. The output of the device under the influence of sound waves was studied on a cathode-ray oscillograph. It proved to be reasonably sinusoidal over a frequency range from several cycles

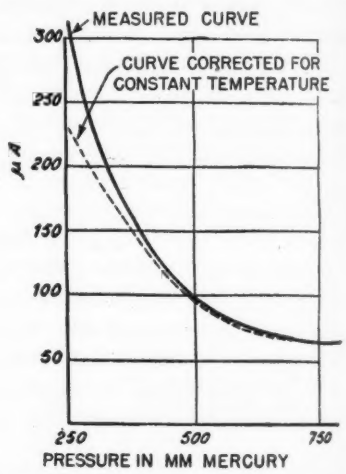


Fig. 3—Dependence of positive ion current intensity on air pressure

per second to 10,000 cycles per second, indicating satisfactory response. It is considered possible to detect ultrasonic waves with a device of this type, because of the high speed that can be imparted to the ions. Further, the inverse operation or an electrically driven sound wave generator, i.e., a loudspeaker, is said to be feasible; it may also be extended to the ultrasonic range.

The study of these phenomena, according to the author, is far from being completed. However, he feels to be in a position to predict considerable advantages from the possible elimination of membranes or similar mechanical oscillating means in acoustical and ultrasonic devices.

*M. S. Klein, L'Onde Electrique, Paris, France, October 1946, pp. 367 to 373.

Phase Detectors

L. I. Farren (Wireless Engineer, London, England, December, 1946, pp. 330-340)

The theory of operation of simple and balanced push-pull phase

detectors is developed. The circuit diagrams are given and the theoretical results compared with experimental values. Sinusoidal and square wave inputs are studied.

Ellipsoidal Cavities

M. Jouguet (Bulletin de la Societe Francaise des Electriciens, Paris, France, 6th series, Vol. V, No. 44, pp. 52-58)

Maxwell's equations are solved for boundary conditions corresponding to metallic cavities in the shape of ellipsoids of revolution. Rotational symmetric waves are considered. Expressions for the lines of constant electric and magnetic field intensities and for the wavelengths are presented.

Design of Multistage Band-Pass Filters

(A. Linnebach, Elektrische Nachrichtentechnik, Berlin, Germany, Vol. 20, No. 10, pp. 238 to 250)

Filter circuits may be used in radio receivers for the selection of a desired station from other undesired signals. Fig. 1 illustrates the

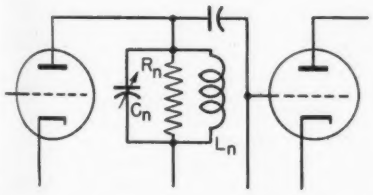


Fig. 1—Band-pass amplifier stage in radio receiver

nth stage of such a band-pass amplifier and Fig. 2 shows the desired band-pass amplifier response. A maximum permissible variation, A, of the amplification factor is specified within the angular frequency interval ω_{min} to ω_{max}, symmetrically located with respect to the angular center frequency ω_o.

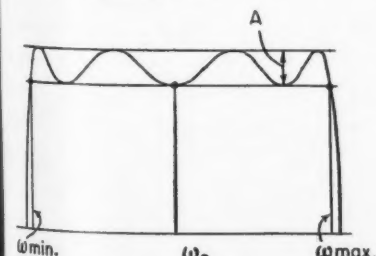


Fig. 2—Desired band-pass response

The problem is solved with the aid of the Tschebyscheff polynomial* which permits to establish the function (amplification factor) that deviates least from a desired value within a given interval of the variable (angular frequency). Eventually the final formulas for the angular frequencies, ω_n, of the nth circuit and for the reciprocal of the time constants, T_n, of the nth circuit, are arrived at; they read:

$$\omega_n - \omega_o = (\omega_{max} - \omega_o)\left[\frac{1}{2d} + \frac{d}{2}\right]\cos\left[\frac{(2n-1)\pi}{2t}\right]$$

$$\frac{1}{T_n} = \frac{1}{2R_nC_n} = (\omega_{max} - \omega_o)\left[\frac{1}{2d} - \frac{d}{2}\right]\sin\left[\frac{(2n-1)\pi}{2t}\right]$$

where t is the number of stages and d may be found from the maximum permissible variation A of the amplification factor by means of the relation:

$$A = 2d^{2t}.$$

The accompanying sine and cosine table facilitates numerical evaluation of the formulae for ω_n and T_n.

t	n		$\cos\frac{2(n-1)\pi}{2t}$	$\sin\frac{2(n-1)\pi}{2t}$
1	1	1	0	1
2	1	2	0,707	0,707
3	1	3	0,866	$\frac{1}{2}$
	2	2	0	1
4	1	4	0,923	0,382
	2	3	0,382	0,923
5	1	5	0,951	0,309
	2	4	0,587	0,809
	3	3	0	1
6	1	6	0,965	0,258
	2	5	0,707	0,707
	3	4	0,258	0,965
8	1	8	0,980	0,195
	2	7	0,831	0,555
	3	6	0,555	0,831
	4	5	0,195	0,980

In practical components, the time constants T_n are limited by the losses in the inductances; the maximum possible value obtainable for time constants be designated by T_{max}. Then the following condition is imposed on the minimum realizable band width:

$$\omega_{max} - \omega_{min} = 4d/[(1-d^2)T_{max}\sin(\pi/2t)]$$

A method to compute the phase shift introduced by a t-stage amplifier is explained.

Antennas

K. Fraenz (Elektrotechnische Zeitschrift, Berlin, Germany, Vol. 65, Nos. 23/24, pp. 229-233)

A survey of various antenna designs is given and their directional diagrams, band widths, and radiation impedances are discussed and compared.

2 to 100 Mc Ultrasonic Waves

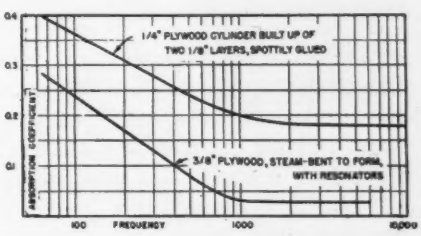
S. Bhagavantam and B. Ramachandu Rao (Nature, London, England, October 5, 1946, Vol. 158, No. 4014, p. 484)

Ultrasonic waves were generated in distilled water by the vibrations of a tourmaline plate, 2 mm thick, and with a resonance frequency of 2 mc; up to the 54th harmonic could be excited. Light diffraction patterns with ultrasonic waves in the range from 2 to 100 mc were obtained and the propagation velocities were compared. Results indicate that no dispersion takes place, i.e., the velocity of wave propagation is constant with respect to frequency.

Sound Absorbing Properties of Plywood Cylinders

C. P. Boner, C. R. Rutherford, and C. F. Seay, Jr. (Paper read at the 26th Meeting of the Acoustical Society of America, Chicago, November 1946)

Preliminary results of tests on acoustical absorption as a function of frequency of cylindrical plywood structures were reported. It appears that, in general, cylinders made of thin plywood laminations spottily glued together have a higher absorption coefficient than cylinders steam-bent to shape from



Plywood cylinders as sound absorbing materials

a single thicker panel. This is demonstrated by comparison of the two curves in the figure.

The authors find the absorption-frequency characteristic of plywood cylinders to be roughly complementary to that of some commercially available absorbing materials so that a flat frequency response may be secured by combining these materials with the cylinders.

Measuring Hysteresis Loops

A. Goldstein (The Brown Boveri Review, Baden, Switzerland, Vol. 32, No. 7, pp. 242 to 246)

The ac hysteresis loops of ferromagnetic materials are determined by means of a ring-shaped core of the material to be investigated

*"Mathematics of Physics and Chemistry," by H. Margenau and G. M. Murphy, page 74. Compare also "Design of Broad Band Amplifiers," by R. F. Baum, Journal of Applied Physics, June 1946.

which is provided with a current coil and a voltage coil. Instantaneous current and voltage values are registered by oscillographs. As the time integral of the voltage is proportional to the magnetic flux density, B, and the current to the magnetic field strength, H, the B-H curve, or magnetizing curve, can be plotted. The method is described in detail and illustrated by numerical examples.

Transient Response of Tuned-Circuit Cascades

D. G. Tucker (Wireless Engineer, London, September, 1946, pp. 250 to 258)

In multi-channel pulse transmission systems in which the pulse is used to operate a relay, such as voice frequency systems or multi-channel telephone trunk signalling systems, the response to transients

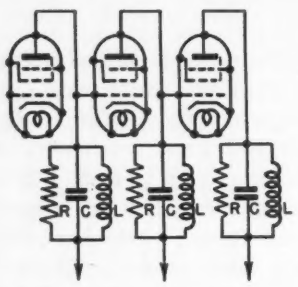


Fig. 1—Three-stage, resonance-circuit coupled amplifier

of the coupling circuit is of great importance. A study of the transient response of a series of resonant circuits, coupled in cascade as indicated in Fig. 1, has been made; all resonant circuits are tuned to the same frequency f_o.

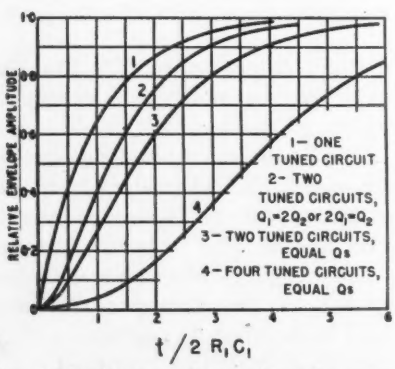


Fig. 2—Build up of transient for resonant frequency pulse

In response to a pulse of frequency f, there will be a transient output at resonant frequency, f_o, and a steady-state output at applied frequency, f. The amplitude of the transient component depends on the phase of the applied sine wave pulse at the instant of switching. Its maximum is equal to the peak of the steady-state output for applied frequencies, f, larger than the resonance frequency, f_o; the maximum amplitude of the transient

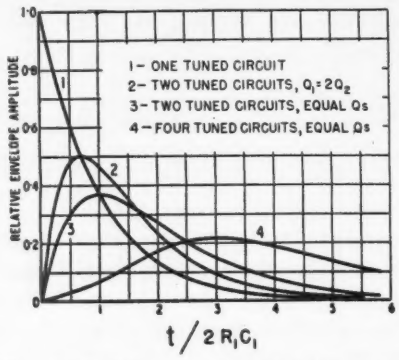

RELATIVE ENVELOPE AMPLITUDE
1— ONE TUNED CIRCUIT
2— TWO TUNED CIRCUITS, Q1=2Q2
3— TWO TUNED CIRCUITS, EQUAL Qs
4— FOUR TUNED CIRCUITS, EQUAL Qs
t/2 R1C1

Fig. 3—Build-up of transient for pulse of frequency far off resonance

component is equal to f_o/f times the peak of the steady-state output for frequencies, f, lower than the resonant frequency, f_o; at very low frequencies the maximum transient may be relatively large.

Expressions for the relative envelope amplitudes of the transient for two and then for any number of circuits in cascade are given. The results are illustrated in Fig. 2 for applied pulses equal to the resonant frequency; flattening of the envelope amplitude and increased time delay of the peak amplitude with an increasing number of circuits is clearly visible. Fig. 3 represents similar curves for off resonance frequencies. A comparison of the performance of tuned-circuit cascades with band-pass filters is given.

Radar Echo from the Sea

H. Goldstein (The Physical Review, December, 1946, pp. 938-946)

Microwave radar indicators are often seriously disturbed by echoes associated with the sea surface. Several hypothesis as to the mechanism responsible for these sea echoes were developed and it is the aim of the present investigation to decide between them. For this purpose frequency dependence of the phenomenon was measured and the difference in behaviour between horizontally and vertically polarized radiation established. It appears that large drops of water rather than surface irregularities cause the sea echo.

Preparation of Carbonates for Cathodes

Ch. Biguenet and C. Mano (Le Vide, Paris, France, Vol. 1, Nos. 4/5, pp. 137-142)

Methodes of preparation of barium-, strontium-, and calcium-carbonates for oxide-coated cathodes are investigated. By varying the temperature and concentration of the original solution from which the carbonate is obtained by precipitation, needle or spherical crystals, or a mixture of both, at a desired size may be obtained. Experimental procedure and results are described.

Mixer Stage in 1000-Line Television Receiver

R. Aschen (La Television Francaise, Paris, France, October, 1946)

In the mixer circuit shown in the first figure, the coupling between the oscillator and the mixer is obtained by means of two wires, one

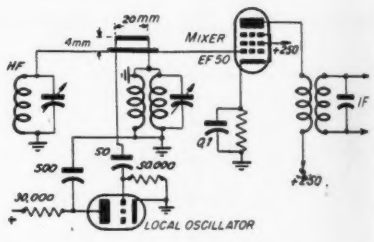


Fig. 1—1000-line television mixer stage

millimeter in diameter, 4 mm apart and 20 mm long. With this circuit, a bias of —2.7 volts, and a local effective oscillator voltage of 0.5 volts, the input resistance of the mixer is 5,500 ohms and its transconductance 1.2 ma/V; for a bias of —3.6 volts and an effective os-

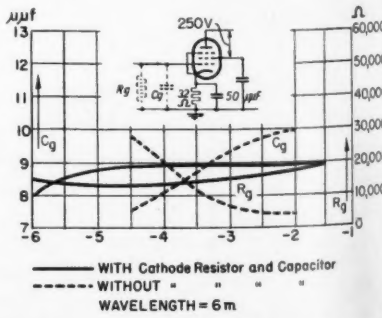


Fig. 2—Improved performance by insertion of capacitor and resistor in the cathode lead

cillator voltage of 1.4 volts, the input resistance is 4,800 ohms and the transconductance 1.8 ma/V.

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4 COAXIAL SPEAKERS
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COAXIAL SPEAKERS

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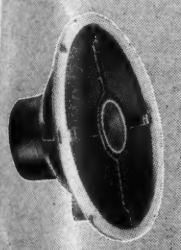
MODEL JAP-60 COAXIAL (ST-600). A 15-inch cone-type Coaxial with PM design. Furnished with H-F Range Control. Nominal input impedance, 500-600 ohms. Maximum power handling capacity in speech and music systems, 20 watts. List Price, $86.00.

MODEL JHP-52 COAXIAL (ST-601). A 15-inch cone-type Coaxial like Model JAP-60 with efficiency approximately 4 db less. Furnished with H-F Range Control. Input impedance, 500-600 ohms. Power handling capacity in speech and music systems, 15 watts. List Price, $65.00.



MODEL JCP-40 COAXIAL (ST-603). A 12-inch Coaxial at low cost. Ideal replacement and modernizing unit where 12-inch speaker is required. Simplified low-cost bridging network inbuilt. Terminals provided for addition of ST-606 Level Control. Nominal input impedance, 6-8 ohms. Power rating, 10 watts in speech and music systems. List Price, $35.

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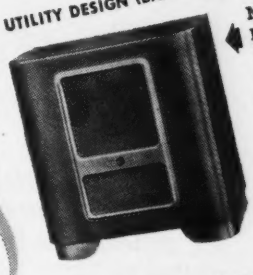
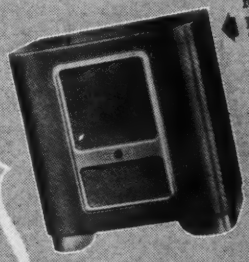


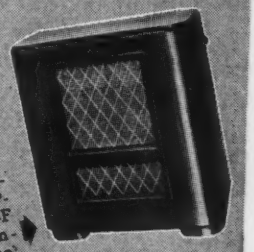
MODEL RA-151. Complete with Model HNP-51 Coaxial and H-F Range Control installed. List Price, $181.15.

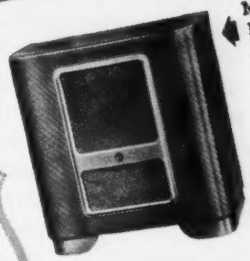
MODEL RD-151. Complete with Model HNP-51 Coaxial and H-F Range Control installed. List Price, $201.00.



MODEL RA-153. Complete with Model JAP-60 Coaxial and H-F Range Control installed. List Price, $142.15.

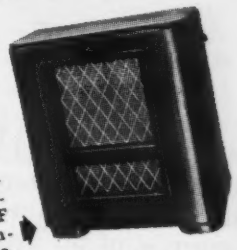
MODEL RD-152. Complete with Model JAP-60 Coaxial and H-F Range Control installed. List Price, $162.00.

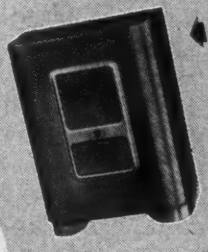




MODEL RA-154. Complete with Model JHP-52 Coaxial and H-F Range Control installed. List Price, $121.15.

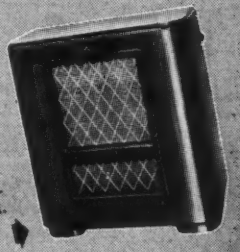
MODEL RD-153. Complete with Model JHP-52 Coaxial and H-F Range Control installed. List Price, $141.00.





MODEL RA-124. Complete with Model JCP-40 Coaxial installed. List Price, $94.15.

MODEL RD-122. Complete with Model JCP-40 Coaxial installed. List Price, $114.00.



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1000-line receiver, high transconductance, small input and output capacitances, large input resistance, and low tube noise are desirable. Improvement of circuit performance may be obtained by insertion of a resistance and capacitance in parallel in the cathode lead (see second figure). Particularly, the input resistance R_g is increased and the input capacitance C_g is less dependent on the grid voltage.

Deflection Beam Tube Amplifier to 750 Mc

M. R. Gavin and G. W. Warren (G.E.C. Journal, London, August, 1946, pp. 97-104)

The sensitivity and input conductance of deflection beam tubes is considered at very high frequencies where the electron transit time, T, between the deflection plates is comparable with the duration $(2\pi/\omega)$ of one cycle of the deflecting field.

The ratio between deflection sensitivity, $C\omega$, at angular deflection voltage frequency, ω, and deflection sensitivity, C_o, at constant deflection voltage, is computed:

$$C_\omega/C_o = \frac{2}{\omega T}\cdot\frac{1}{1+2r}\left[1+2(1-\cos\omega T)\left\{\frac{1}{(\omega T)^2}+r(1+r)\right\}-\frac{2\sin\omega T}{\omega T}\right]^{\frac{1}{2}}$$

This ratio is plotted in Fig. 1 as a function of the transit angle, ωT, the product of the angular frequency, ω, of the deflection voltage

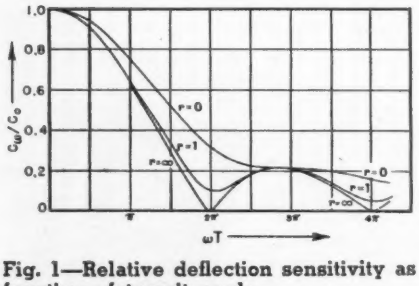


Fig. 1—Relative deflection sensitivity as function of transit angle

and the time, T, each electron travels in the space between the deflecting plates; r is the ratio of electron travel time from the deflecting plates to the anode to the transit time, T. It will be appreciated that the curve marked $r=0$ illustrates the sensitivity at the end of the deflecting plates, while $r=\infty$ corresponds to standard cathode-ray tube design. A value of $r=1$ appears to be advantageous for very high frequency applications.

Energy considerations (equating the average value of the kinetic energy acquired by the electrons minus the potential energy lost by the electrons, during passage through the deflecting field, to the energy supplied by the deflecting field source) permit an equivalent input conductance to be computed.

In practical units the input conductance, g, is given by:

$$g = 1.8\times10^{15}\cdot\frac{IT^2}{a^2}F(\omega T)$$

where $F(\omega T)=\dfrac{2-2\cos\omega T-\omega T\sin\omega T}{(\omega T)^2}$

while I is the current intensity and a the distance between the deflecting plates. The function $F(\omega T)$ is plotted in figure 2 for ready exam-

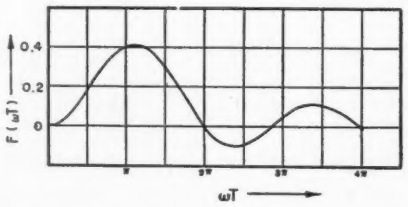


Fig. 2—Curve illustrates dependence of input conductance on transit angle

ination; it illustrates the dependence of the input conductance on frequency. From Fig. 2 it will be seen that the conductance is zero at zero frequency (no power is consumed); it then increases as the square of the frequency for transit angles smaller than about $\pi/2$ and reaches a maximum at a transit angle approximately equal to π.

Sensitivity graph and input conductance graph suggest a value of 3π radians for the transit angle ωT. A tube has been designed for use with parallel wire transmission line circuits connected to the deflector plates and to the anodes. It has a specially shaped suppressor plate inserted between the two anode segments to prevent secondary electrons released by one segment being captured by the other segment. With the deflector plates at 20 volts and the anodes at 400 volts, the mutual conductance is about 1ma/volt at a total cathode current of 6 ma. At 200 mc, the input resistance is between 15,000 and 20,000 ohms and the gain per stage is 13 db. Deflected beam tube amplifiers have been developed for frequencies up to 750 mc, where a mutual conductance of 5 ma/volt at 4 ma cathode current and considerable power gain can be secured.

As regards sensitivity and input resistance deflection control tubes compare favorably with grid control tubes at high frequencies. However, experimental work led to the conclusion that shot noise associated with the electron beam and with division of current between the two anode segments makes tubes of this type inferior to modern high frequency triodes as amplifiers of very small signals.

Nuclear Absorption Measurements

E. M. Purcell, R. V. Pound, and N. Bloembergen (Physical Review, December, 1946, pp. 986-988)

Hydrogen nuclei appear to absorb radio frequency energy at a well defined frequency. Similar effects are reported from fluorite crystals when inserted in a strong magnetic field. It is suggested to use this phenomenon for the determination of hydrogen concentration.

Behavior of Electron Stream in Electric Field

H. W. Koenig, Tube Laboratory of the Wernerwerke for Communication Apparatus of the Siemens & Halske A.-G. (Hochfrequenstechnik und Elektroakustik, Berlin, Germany, Vol. 62, pages 76 to 86)

Electrons traveling parallel in a beam extending in the direction of an electric field — conditions obtained with good approximation in velocity-modulated tubes—are considered. Electron velocity, voltage, and efficiency as function of time and space are studied, the space charge effect being taken into account.

Cathode-Excited Linear Amplifiers

J. J. Muller, Laboratoire Central de Telecommunications, Paris (Electrical Communication, Vol. 23, No. 3, 1946, pp. 297 to 305)

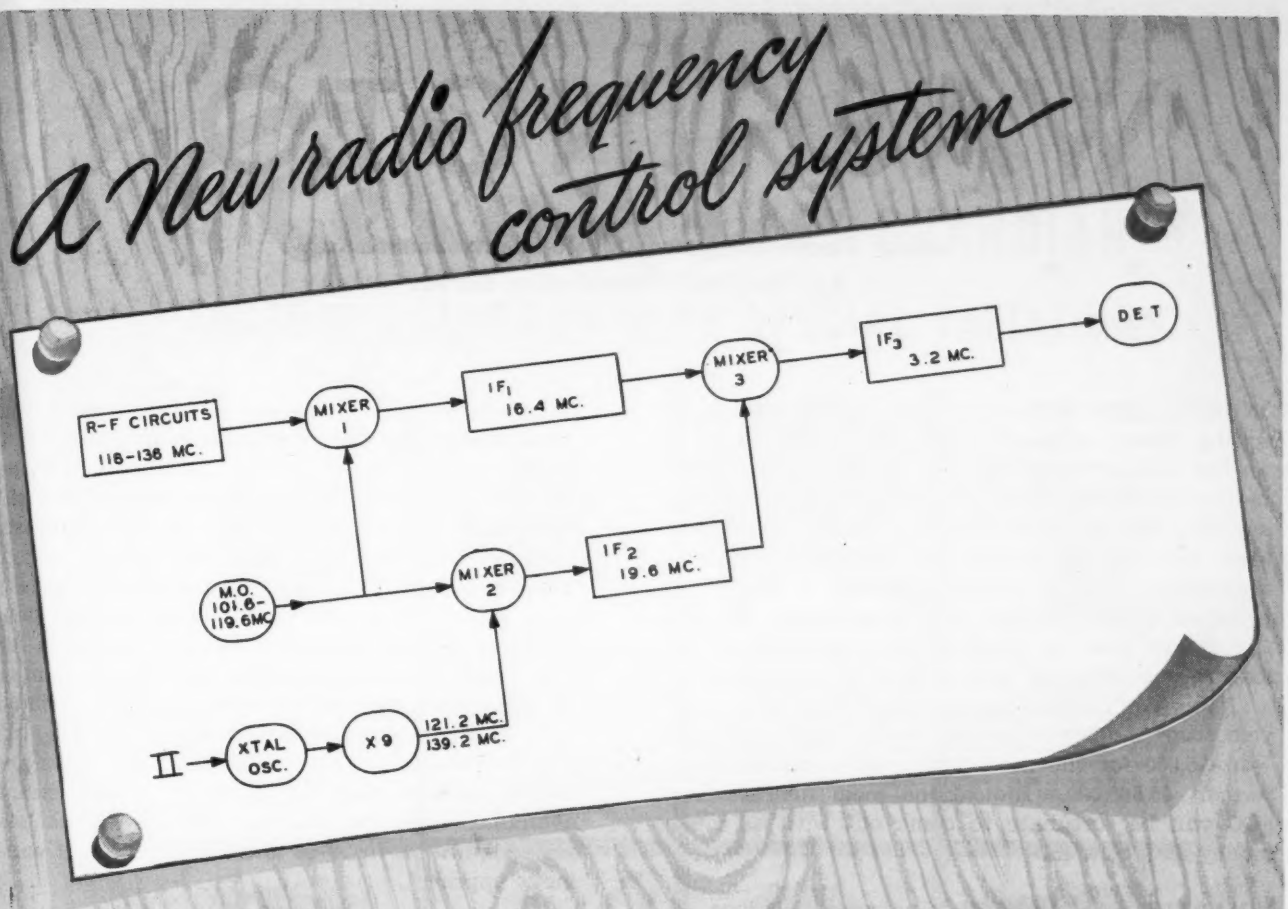
Neutralization of cathode-excited amplifiers by providing capacitors C_n of values which differ from the internal tube capacitances and inserting an appropriate reactance 2Z between the grids of symmetrical amplifiers is considered. The value of the reactance, 2Z, may be found from the expression:

$$Z = (X_{fg}X_{gp}) : (X_{fg}+X_{gp}+X_{fp}-X_n)$$

where the X's indicate the react-

(Continued on page 131)

A New radio frequency control system



The Collins Drift Cancelled Oscillator

The DCO (Drift Cancelled Oscillator) circuit, an exclusive Collins development, is a new frequency control method that meets the needs of modern communication problems. Basically it provides the multiplicity of channels and the freedom from the spurious responses inherent in Master Oscillator operation, but with the stability of a single crystal.

The Collins 51M-2 VHF ground station receiver is the first of a series of Collins products employing the DCO principle. The diagram shown above illustrates the 51M-2 circuit. Injection voltage for the first mixer is supplied by the M.O. operating at the injection frequency. There are no unwanted harmonics as there would be if a low frequency crystal were used to generate the injection voltage. The M.O. also provides the injection voltage for Mixer 2, where it combines with the output of the crystal oscillator and produces IF_2. Mixer 3 combines IF_1 and IF_2 to obtain IF_3. Both IF_1 and IF_2 reflect in the same sense any M.O. instability, hence the M.O. drift is cancelled out. The stability of the receiver is determined only by the 0.005% accuracy of the crystal.

Use of the DCO principle in the 51M-2 results in spurious responses 100 db below that of the desired signal and permits operation of several receivers from a single antenna:

51M-2 SPECIFICATIONS:

Application: single channel ground station reception.

Freq. range: 118-136 mc.

Sensitivity: 1 microvolt r-f input 30% modulated for a 6 db signal to noise ratio.

Stability: 0.005%.

Spurious response: down 100 db.

Avc: output constant within 3.0 db with input range of 1 microvolt to 1 volt.

Other features: audio squelch, noise limiter, remote control.

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WASHINGTON

★ ★ ★ **Latest Electronic News Developments Summarized by *Tele-Tech*'s Washington Bureau** ★ ★ ★

CONGRESS AND FCC—Most important development during March on Capitol Hill for the FCC is to be annual trek of Commissioners and top staff officials before the House Appropriations Committee for the agency's 1948 fiscal year budget. It will be a rough time, too, for the Commission spokesmen from all indications, with a drastic slashing of the FCC's proposed funds certain. The Commission, despite the known goal of Congress to wield an economy axe on governmental appropriations, has asked for a $1.3 million increase in its funds for the next fiscal year, starting July 1 over the current appropriation —$6,875,000 for the next fiscal year compared with present $5,560,000. Indications seem definite that FCC will be fortunate to come out with as much money as it now has.

LEGISLATION IN OFFING—Chairman Wallace H. White of Senate Interstate Commerce Committee, regarded as the ablest authority on communications and radio in Congress, is planning to introduce legislation some time during the current session of Congress to revamp the Communications Act in regard to its procedures on the granting of broadcasting stations, particularly, and also to bring the statute up to date for the handling of the new postwar radio services in the aviation and mobile fields.

LOWER BAND FOR FM?—No timetable for the introduction of the measure has yet been set by Senator White, who also holds the powerful position of Senate Majority Leader, and, contrary to reports in some radio publications, he told *Tele-Tech* that "there is nothing imminent" about the introduction of his measure. Two other legislative proposals, affecting the FCC and broadcasting,—a bill by Rep. Lemke (R., N.D.) to reinstate the lower band for FM broadcasting, and a measure by Rep. Hare (R., Ore.) for the FCC to curb mystery programs on the air—are felt to have little chance of Congressional enactment. So far there is little actual foundation for the rumors of a sweeping House Committee investigation of the FCC.

MICROWAVE RELAY AND MOBILE RADIO—The two-day oral argument of the FCC in early February in these two fields of frequency allocation revealed that generally the communications and radio manufacturing industries were in accord with the principles in the microwave field of full development until all factors are known and in the mobile radiotelephone services there was a crying need for more frequencies. In the microwave relay sphere of the spectrum, the plans of the telephone companies for extensive radio relay systems precipitated views from such important segments of the broadcasting industry as Television Broadcasters Association, the networks, and from the manufacturing industry, like Philco, that television broadcasting station licensees should have the right to establish their own relay systems if the latter desired such ventures. In the mobile radiotelephone services, the Bell System, Independent Telephone Industry, bus, truck and taxi industries all wanted more spectrum space as the demand was far in excess of the channels available. However, the FCC block system of service assignments in 30-40 and 152-162 mc met unanimous approval.

VALUABLE WORK—The Office of Technical Services of the Commerce Department, of which Edwin Y. Webb, Jr., is the Communications-Electronics Section Chief, has performed valuable service to the U. S. radio manufacturing industry in bringing back from Germany to this country inventions, developments and processes, gleaned by its staff of scientific investigators. Fully 50 major developments, of which the Bosch paper condenser is an outstanding example, and over 1,000 other inventions and processes have been made available to the American radio-electronics industry through the investigations of the OTS experts in Germany.

"NEIGHBORHOOD" RELAY STATIONS—Webb, who is largely responsible for the successes of this government agency in the radio-electronics field, has just gone to Germany for several weeks to intensify and expand the inquiries into German methods and plants. A recent report exemplified the value of this work—a German plan for television "neighborhood" relay stations so as to expand home reception on lower-priced sets was revealed to the Commerce Department's OTS by former Telefunken Television Laboratory Director Shroeter. (Copies of this report can be purchased from the Commerce Department.) Another interesting recent report was that of the Cruft Laboratory on how FM can provide clearer reception for VHF airborne radiocommunications sets.

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Washington Editor

Relays BY GUARDIAN

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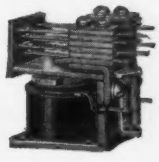
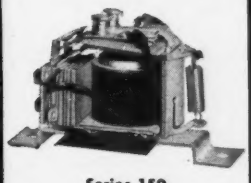


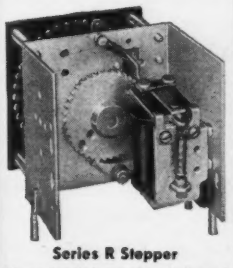
Series 500
Midget Relay

Use this relay where space, weight and maximum power delivery are primary factors. Sturdy. Offers many contact combinations. Maximum contact control capacity 8 amps. Fits in approximately 1½ cu. in. space.



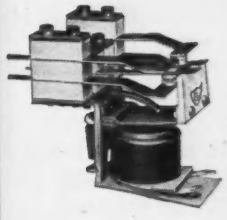
Series 150

Suitable where a small A.C. control relay is needed or if exposed to possible maladjustment. Equipped with "special" spring tension contacts which "make" before the armature fully completes its travel. Remaining armature movement is taken up by the contact coil spring insuring a firm, wiping contact.



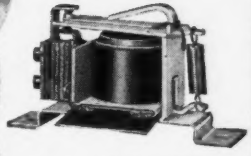
Series R Stepper

Three basic types for A.C. and D.C. operation: (1) Continuous rotation, (2) Electrical reset, (3) Add and subtract. For automatic circuit selection including automatic sequence; automatic wave changing on short wave transmitters; business machines; totalizers; conveyor controls, etc.



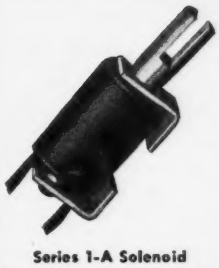
Series A-100
High Frequency

A1SiMag insulated, compact, low cost. For antenna changeover; break-in; hi-voltage keying; remote control of receiver and transmitter and other high frequency applications.



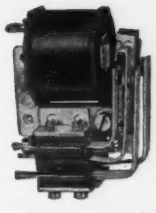
Series 120

A small, compact relay. An economical unit designed for control up to single pole double throw. Unique armature assembly prevents arcing. Low priced, yet high in quality and performance.



Series 1-A Solenoid

The series 1-A Solenoid by Guardian is one of numerous types for intermittent and continuous duty. Applications include valve control and operation; electrical locking; clutch and brake operation; material ejection; spray gun operation among others.



Series 40 A.C.
Laminated Relay

Designed to produce maximum output with minimum current input. Typical uses include control of call system bells; auxiliary for automatic radio tuning; remote control of fractional motors; safety devices; instruments; sound movie auxiliaries.

Guardian Switches

Switch assemblies by Guardian are unlimited, ranging from a single set of contact blades up to multiple stacks. The Guardian Featherub Switch shown is actuated mechanically. Operates on manual, roll-over or cam action. There are hundreds of others. Contact blades are obtainable in phosphor bronze, tinned to withstand salt spray test, or standard Guardian phosphor bronze.

Introducing a new product? Redesigning an established favorite? You may be thinking in terms of a "special" electrical control. Yet, a *basic* type Guardian Relay—Stepper—Contactor—Solenoid—or Switch Assembly (each adaptable to many variations) may meet your "special" control requirements with utmost efficiency. In such applications where *standard* Guardian units become "specials," the savings in time and money are substantial and you beat delivery schedules in the bargain. We urge you—study the *standard* Guardian units pictured and described above—there are many more fully illustrated in the Guardian Relay catalog giving complete operating details and variable contact data for each. Your copy is waiting. Write.

GUARDIAN ELECTRIC

1622-C W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

Feller

Density of Radio Receivers Throughout World

Rank of all nations as related to the total number of listeners in each per thousand population—Data supplements color map-chart

• Great interest was created among readers by the statistics on radio transmitters and receivers here and abroad, presented in our January issue, with chart-map in colors. The figures there shown gave powers and numbers of transmitters, numbers of receivers, percentages of line-operated and battery-operated sets, and percentages of receivers imported in the respective countries.

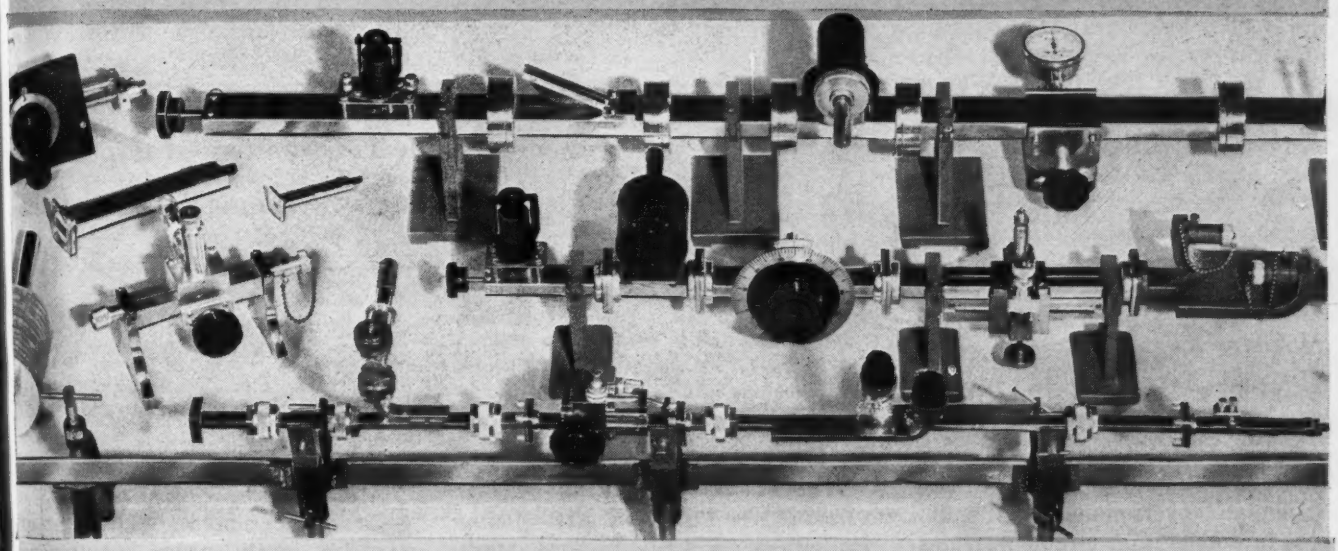
Another factor of great importance in studying export markets, is the number of radio sets in use per unit of population. While the chart sent as a supplement to January TELE-TECH showed such radio-set density by countries, graphically, detail figures furnished by Dr. Arno Huth, international radio consultant, are now presented here, with the nations listed in the order of their rank as radio listeners.

Rank	Sets per 1000 Pop.	Country
1	425	United States
2	282	Sweden
3	265.4	Denmark
4	230.1 (1944)	New Zealand
5	217.1 (1944)	Iceland
6	217	Great Britain and Northern Ireland
7	203.3	Switzerland
8	193.8 (1945)	Australia
9	167.7 (1944)	Germany
10	152.5	Canada
11	146.7	France
12	141 (1945)	Finland
13	118.1 (1941)	Hawaii
14	117	Austria
15	ca. 110 (162.3 1943)	Netherlands
16	100	Luxembourg
17	99.3 (1944)	Hungary
18	99.2	Czechoslovakia
19	93.5	Argentina
20	93.3 (1943)	Japan
21	ca. 83.5 (136.9 in 1940)	Belgium
22	79.9	Newfoundland
23	68.1 (145.5 1941)	Norway
24	62.1 (1940)	Russia
25	59.1	Ireland (Eire)
26	52.3	Cuba
27	47.7	Chile
28	39	Venezuela
29	37	Palestine
30	35	Union of South Africa
31	32.7 (40.7 in 1943)	Italy
32	32.1	Puerto Rico
33	30.4 (1939)	Lybia
34	29.8	Costa Rica
35	29.1	Mexico
36	28.4	Curacao
37	27.3	Bahamas
38	27	Brazil
39	23.6	Panama
40	21.6	British Honduras
41	21	Colombia
42	20.9 (1944)	Rumania
43	20.8 (1944)	Bulgaria
44	18.6	Malta
45	16.6	Portugal
46	16	Spanish Morocco
47	15 (1943)	Tunisia
48	14.4	Paraguay
49	14.3 (1943)	Algeria
50	14.2	Peru
51	14.1	Bolivia
52	14 (1944)	Spain
53	13.6	Honduras
54	11.6 (1944)	Manchukuo
55	11.5	Canary Isles
56	11 (1944)	Syria & Lebanon
56-A	11 (1940)	Hongkong
57	10.4 (1941)	Straits Settlements
58	9.4	Turkey
59	9.2	Yugoslavia
60	8.3 (1940)	Southern Rhodesia
61	8	Uruguay
62	7.6	French Morocco
63	6.9	Guatemala
64	6.8	Nicaragua
65	6.5	Ecuador
66	6.1 (1945)	Martinique
67	5.9	Poland
68	5.4 (1941)	Egypt
69	5.3	El Salvador
70	4.9 (1943)	Greece
71	4.8	Jamaica
72	4.3	Dominican Republic
73	3.1 (1940)	Philippines
74	3 (1941)	Thailand
75	2.7 (1945)	Guadeloupe
76	1.6 (1941)	Netherlands East Indies
77	1.4 (1940)	Kenya
78	1.3	Haiti
79	1.2	China
80	1.1 (1939)	Ceylon
80-A	1.1 (1942)	Angola
81	1 (1942)	Mozambique
82	0.7	British India
83	0.3 (1941)	French Indochina
84	0.2 (1940)	Iran
85	0.1 (1941)	Afghanistan

RADIO SETS IN USE, BY CONTINENTS

DE MORNAY BUDD STANDARD TEST EQUIPMENT

For Precision Measurements in the Microwave Field



The complete line of De Mornay·Budd standard test equipment covers the frequency range from 4,000 mcs. to 27,000 mcs. It provides all R. F. waveguide units necessary for delicate, precision test work requiring extremely high accuracy in attenuation measurements, impedance measurements, impedance matching, calibration of directional couplers, VSWR frequency measurements, etc.

To eliminate guesswork, each item of this De Mornay·Budd test equipment is individually tested and, where necessary, calibrated, and each piece is tagged with its electrical characteristics. All test equipment is supplied with inner and outer surfaces gold plated unless otherwise specified.

NOTE: Write for complete catalog of De Mornay·Budd Standard Components and Standard Bench Test Equipment. Be sure to have a copy in your reference files. Write for it today.

The three test set-ups illustrated above include:

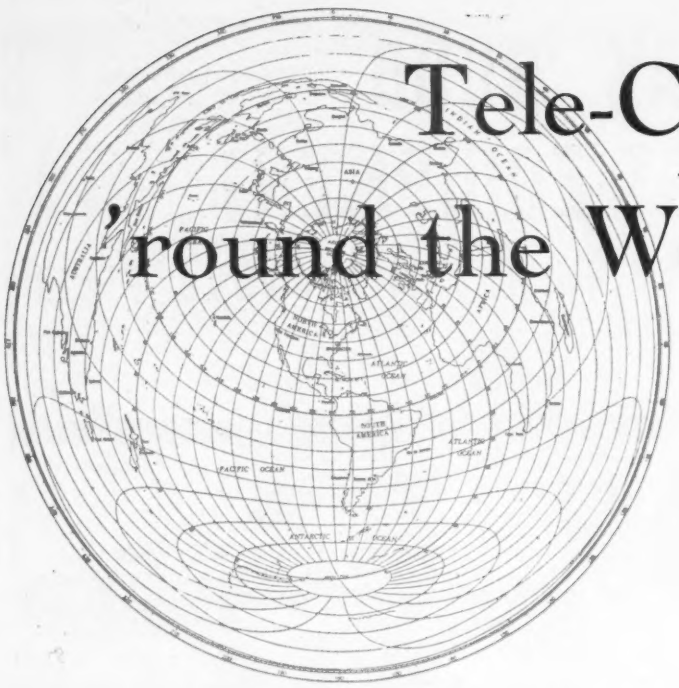
- Tube Mount
- Flap Attenuator
- Frequency Meter
- Calibrated Attenuator
- Tee
- Stub Tuner
- Tunable Dummy Load
- Standing Wave Detector
- Type "N" Standing Wave Detector
- Directional Coupler
- Hight Power Dummy Load
- Cut-Off Attenuator

Stands, etc.

DE MORNAY BUDD

EQUIPMENT FOR 97% OF ALL RADAR SETS

DE MORNAY • BUDD INC., 475 GRAND CONCOURSE, NEW YORK 51, NEW YORK. CABLE ADDRESS "DEMBUD," N. Y.



Tele-Communications 'round the World

By ROLAND B. DAVIES,
Tele-Tech Washington Bureau

News of engineering matters of importance and of markets in various foreign fields

MACKAY RADIO CONTRACT WITH ETHIOPIAN GOVERNMENT—A new contract between Mackay Radio & Telegraph Co. and the Ethiopian government for the direct radiotelegraph circuit provides that Mackey will furnish the Ethiopian Ministry of Posts, Telegraphs and Telephones a "technical director" for the operation and maintenance of that country's radiotelegraph and radiotelephone stations.

NEWFOUNDLAND BROADCASTING—Radio broadcasting in Newfoundland is under government control but, unlike its mother country's British Broadcasting Corp., the Broadcasting Corp. of Newfoundland accepts advertising to help defray expenses of the system. At the same time the Newfoundland government allows one private company—the Colonial Broadcasting Co.—with one station, to operate in the country. However, the private station, VOCM, is low-powered and it is reported the government has no intention of allowing it an increase in power or of allowing other private companies to set up stations.

Newfoundland has 25,000 licensed receivers and its income from this source is about $45,000. The BCN operates two stations and realizes a profit of from $12,000 to $25,000 per year. The government also plans to establish two new stations, one at Gander and the other at Grand Falls, and to erect a Broadcasting House at St. John's.

MEXICO'S NEWEST HIGH POWER STATION ON AIR—Using equipment furnished by RCA, Mexico has placed on the air its newest high powered station XERF at Villa Acuna, opposite Del Rio. The station started operations with 50 kw on 1570 kc (clear channel), but plans to have its power increased to 150 kw.

RADIO PRODUCTION IN U. S. ZONE OF GERMANY LAGS—Radio receiver production in the United States Zone of Germany for the first eight months of 1946 totaled 35,834 with 5,768 being manufactured in August, according to a Department of Commerce report. Loud speakers in the U. S. sector for the 8-month period numbered 88,366 of which 13,772 were produced in the month of August. Monthly figures on production in the U. S. Zone indicated that there was a sharp drop-off in production as the year progressed.

IRAQ ORDERS RADIO EQUIPMENT FROM MARCONI—The Iraq government has placed an order with the Marconi Co. of England for equipment to be used in a broadcasting station to be built at Abu Craib, near Baghdad. The equipment will consist of a 20 kw, medium-wave transmitter, a 15 kw shortwave transmitter and one 25 kw shortwave set for radiotelegraph.

AUSTRALIA INSTALLS RADAR—Besides equipping a number of airfields with radar equipment, Australia has installed radar in fifteen meteorological stations for use in gathering weather information. The radar units, which are of a naval type developed during the war and to be supplied by the United Kingdom, will be in operation before the end of the year.

BRITISH TO EMPHASIZE EXPERIMENTATION IN FM—The British Broadcasting Corporation was characterized as "fully alive" to the possibilities of frequency modulation and had commenced extensive experimentation directly after the end of the war, it was brought out by Assistant Postmaster Burke in a recent debate in the House of Commons. The BBC is engaging in FM as a means of alleviating the frequency shortage problem. Burke, in his discussion of these FM plans, brought out that RCA President Sarnoff in his trip to England last year had highly complimented British radio engineers and he said "General Sarnoff, as President of the Radio Corporation of America, is not without knowledge of these things." Meanwhile, the British radio listening audience has been grumbling against the price of tubes in Eng-

(*Continued on page* 146)

News of the Industry

RMA Engineers Meet In Syracuse April 28-30

Engineering department of the Radio Manufacturers Association has scheduled its Spring Meeting for the three days April 28-30, and the gathering will be housed in the Hotel Syracuse, Syracuse, N. Y. Several of the sessions are to be devoted to problems of television broadcasting and reception.

Dr. W. R. G. Baker, director of the RMA Engineering Department, will be toastmaster at the dinner, April 29. Fred R. Lack, RMA Director and vice-president of Western Electric Co., New York, will speak on "Thirty Years in Transmitter Design."

The program for the technical sessions includes these papers:

"Absolute vs. Industrial Standardization," by C. H. Crawford, General Electric Co.
"Characteristics and Circuit Applications of a New Low-Power Tetrode," by H. C. M. Longacre, Sylvania Electric Products Inc.
"Color Television Transmitter Design in the UHF," by J. P. Wilmer, Columbia Broadcasting System.
"Design Consideration in an Automatic Gain Control and Limiting Amplifier," by William Jurek, Langevin Co.
"Frequency Modulated Link," by E. Ostlund, Federal Telecommunications Laboratories.
"Design Considerations for Commercial Radar Equipment," by Coleman London, Westinghouse Electric Corp.
"Television Studio Control Including Camera Dolly Considerations," by C. E. Hallmark, Farnsworth Television & Radio Corp.
"Navigational Computers," by A. C. Omberg, Bendix Aviation Corp.

World Conference Scheduled for May 15

The World Telecommunications Conference is to be held in Atlantic City, N. J., at the Ambassador hotel, beginning May 15. Membership of the American delegation has not been made public though it is expected that many of the foreign representatives will establish offices in the convention hotel, or nearby, about the end of April.

Broadcast Engineering Meet

The Georgia Association of Broadcasters and the Georgia Chapter of the Institute of Radio Engineers, in cooperation with the Georgia School of Technology, are sponsoring a Radio Broadcast Engineering Institute in Atlanta, Ga., April 14-18, 1947. Experts will cover the latest developments in studio design and equipment, antennas, recording and reproducing, FM systems, facsimile broadcasting, and television studios, studio equipment, transmitters and receivers. Manufacturers will exhibit.

For outstanding services to the United States during World War II, Major Edwin H. Armstrong, inventor of FM, received the Medal for Merit, highest civilian decoration, from Chief Signal Officer Major General Harry C. Ingles

Boston Newspaper Gets Radio Press Relay

Indicating possible further expansion of such services, FCC has authorized the Boston Herald-Traveller, newspaper, to erect a land radio station and equip a mobile station for the transmission of news. Installation will be made under rules governing press relay stations.

1946 Production Is Highest in History

Radio set production in 1946 broke all previous records for the industry while FM-AM and television receivers reached their peak in December, indicating a steadily rising growth of these two new services in 1947, according to the Radio Manufacturers Association.

Information from all industry sources, RMA said, reveals that production of all types of radio receivers in 1946 exceeded 15,000,000. The greatest prewar set production was 13,642,334, achieved in 1941.

FM-AM and television receiver production rose sharply in December and brought the year's output to 181,485 FM-AM sets and 6,476 television receivers. December alone accounted for 40,903 FM sets and 3,561 television receivers. Total December set production, through December 27, by RMA member-companies, amounted to 1,454,687, which was slightly under November's production due to the December holidays, and the shorter work-month.

Approximately 77% of all radio sets manufactured by RMA members in 1946 were of the table model type, while consoles constituted about 7%. A shortage of wood cabinets was largely responsible for the low console output.

Due to reconversion and pricing difficulties radio set production was

(*Continued on page* 148)

CONVENTIONS AND MEETINGS AHEAD

Mar. 3-6—Institute of Radio Engineers—Annual Meeting (Commodore Hotel) and Show (Grand Central Palace), New York.

Mar. 22-27—Western Metal Congress and Exposition—Oakland Civic Auditorium, Oakland, Calif.

Mar. 31-Apr. 2—Midwest Power Conference—Palmer House, Chicago.

Apr. 14-18—Radio Broadcast Engineering Institute—Sponsored by the Georgia Assn. of Broadcasters and the Georgia Chapter of IRE in cooperation with the Georgia School of Technology, Atlanta, Ga.

Apr. 28-30—RMA (Engineering Dept.) Spring Meeting—Hotel Syracuse, Syracuse, N. Y.

May 4-8—National Electrical Wholesalers Assn.—38th Annual Convention, Hotel Traymore, Atlantic City, N. J.

May 6-10—Society of the Plastics Industry—Annual Convention (Stevens Hotel) and National Plastics Exposition (Coliseum), Chicago.

May 13-16—Radio Parts and Electronic Equipment Conference and Show—Stevens Hotel, Chicago.

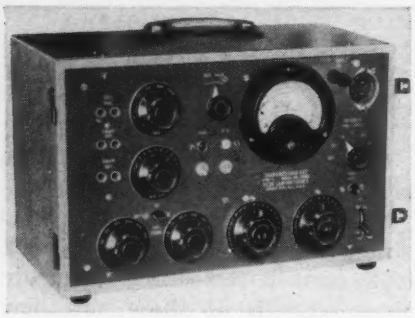
May 15—World Telecommunications Conference—Ambassador Hotel, Atlantic City, N. J.

May 17—Institute of Radio Engineers, North Atlantic Region—Radio engineering meeting, Hotel Continental, Cambridge, Mass. John M. Clayton, General Radio Co., Cambridge.

June 16-20—American Society for Testing Materials—Annual (15th) Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

Sept. 8-12—Second National Instrument Conference and Exhibit—Hotel Stevens, Chicago.

New Lab and Test Equipment



AUDIO GAIN TEST SET

(Use Inquiry Card, Mentioning No. 31)

Designed for use by radio stations, Type 1A transmission measuring set combines in one unit a vacuum tube voltmeter with 80 db range, an audio oscillator with four fixed frequencies between 100 cps and 10 kc, and a precision attenuator flat to 20 kc, with a 93 db range in .1 db steps. The instrument is for use on 115 volts, 60 cycles ac, and consumes 70 watts.—*Tech Laboratories, Inc.*, 337 *Central Ave., Jersey City* 7, *N. J.*

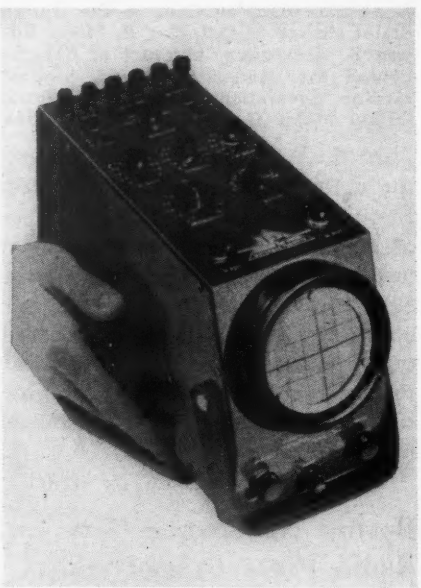
VTVM LABORATORY KIT

(Use Inquiry Card, Mentioning No. 32)

Only a screwdriver and soldering iron are required to assemble and wire this "laboratory kit" vacuum tube voltmeter, which is in the price class of service man's equipment. The instrument will measure voltages from 0.2 to 300 volts at 20 cycles to beyond 200 mc. Accuracy is better than ± 3% on all five ranges, the input capacitance consisting of less than 7 mmfd. The frequency response is down 1 db at 20 cycles and up less than 2.5 db at 150 mcs. Four tested and matched tubes are supplied with the kit.—*Frederick D. Schottland*, 104-18 *Metropolitan Ave., Forest Hills, New York.*

ANNOUNCEMENT

For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 98 in this issue, and *Identify the product by the number assigned to it.*



PORTABLE OSCILLOSCOPE

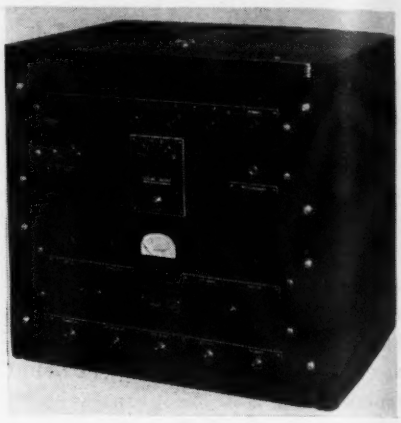
(Use Inquiry Card, Mentioning No. 33)

Designed for industrial and television applications, model S-11A Pocketscope is only slightly larger than its sister instrument model S-10A, but has a 3-in. screen and permits measurement of dc and ac. The instrument is provided with vertical and horizontal push-pull amplifiers, intensity modulation amplifier, and a linear time sweep from 3 cycles to 50 kc. A retractable light shield and detachable graph screen add to the general utility of the instrument.—*Waterman Products Co., Philadelphia* 25, *Pa.*

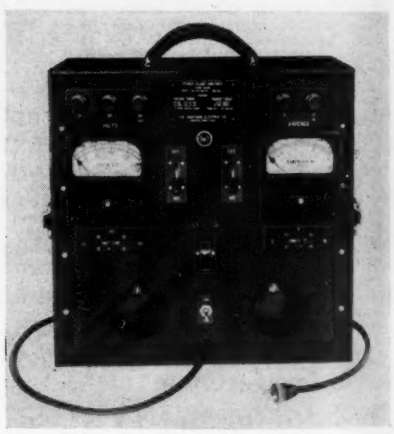
GEIGER-MUELLER LAB. SET

(Use Inquiry Card, Mentioning No. 34)

For making precise laboratory measurements of high intensity and weak radiation sources, the GL-532C high-speed counter set consists of an extension amplifier, amplifier stage for sharpening, equalizing and inverting pulses, a five-stage scaling circuit with ratios of 2, 4, 8, 16 and 32, a two-stage recorder circuit for operating an



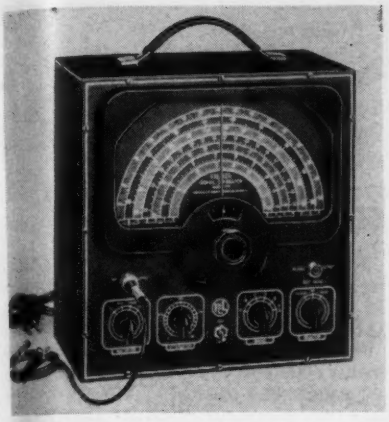
impulse register, and diverse power supplies. The regulated high voltage power supply for the Geiger-Mueller counter tube is variable up to 2000 volts and regulates within 1%. The instrument is of rack-panel construction and operates from 115 volt, 60 cycle power line. It uses 28 tubes.—*Herbach & Rademan, Inc.*, 517 *Ludlow St., Philadelphia* 6, *Pa.*



AC POWER SUPPLY

(Use Inquiry Card, Mentioning No. 35)

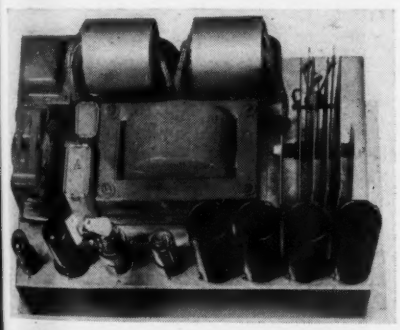
Designed primarily as a test supply for light company testers the power plant Voltbox is a means of obtaining continuously variable ac voltage and current for diversified applications. Three ranges of output voltages from 0-30, 0-150 and 0-300 and two ranges of output current from 0-5 and 0-20 amps. are available. Independently variable voltage and current electrically isolated from each other is achieved by two Powerstat transformers in conjunction with auxiliary transformers. Meter switches are provided to measure external voltages and currents. The unit is equipped with circuit breaker and can be used on 115 or 230 volts, 50-60 cycles, ac.—*Superior Electric Co.*, 2106 *Church St., Bristol, Conn.*



SIGNAL GENERATOR

(Use Inquiry Card, Mentioning No. 36)

Precision tuning signal generator model 570 has a frequency range from 75 kc to 50 mc on fundamentals and up to 150 mc on third harmonics making it suitable for FM and television alignment. Calibration is accurate to 0.5% up to 1600 kc and 1% on higher frequencies. A 400 cps audio modulating signal with less than 5% distortion is provided. A precision dial contains spring-loaded split gears to eliminate backlash and provide close tuning. Air trimmers are used on all bands.—*Premier Electronic Laboratories,* 382 *Lafayette St., New York* 3.



REGULATED POWER SUPPLIES

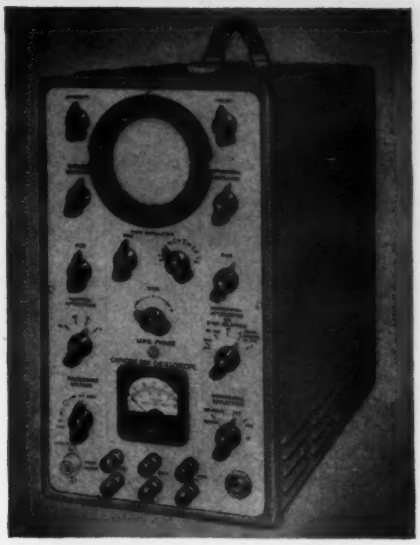
(Use Inquiry Card, Mentioning No. 37)

Regulated dc at currents and stabilities previously available only with batteries are possible with Nobatron voltage regulation units, which are available in six standard models. The units operate on 95-125 volts, 50-60 cycle, ac and provide amperages of 5, 10, or 15 with output voltages of 6, 12 or 28 volts respectively. Regulation accuracy is 0.5%, maximum ripple voltage (rms) 1%, and recovery time ⅛th second. The units operate in ambient temperatures from —50C° to +50°C and are provided with voltage adjustment, fuses, and pilot light.—*Sorenson & Co., Inc.,* 375 *Fairfield Ave., Stamford, Conn.*

WIDE RANGE OSCILLOSCOPE

(Use Inquiry Card, Mentioning No. 38)

Designed to achieve detailed observation of extremely short and steep pulses produced by television synchronizing and deflection circuits, pulse generators and radar



equipment, the portable 3-in. oscilloscope type WO-79A makes possible the accurate measurement of frequency components up to 6 mc in transient and pulsed voltages of the order of one microsecond. One of the first instruments of this size meeting laboratory requirements for accuracy, the unit includes calibrated horizontal and vertical input attenuators and amplifiers, synchronizing amplifier, low and high voltage power supplies and cathode ray tube. Voltage amplitude of the signal can be determined by means of a built-in calibrated voltmeter.—*RCA Victor Div., Radio Corp. of America, Camden, N. J.*

NEW COMMUNICATIONS COMPONENTS—PAGE 116

VOLT-OHM-MILLIAMMETER

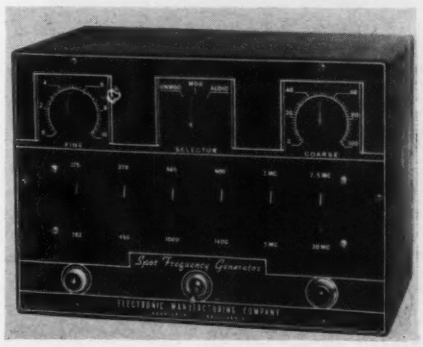
(Use Inquiry Card, Mentioning No. 39)

Intended for laboratory applications and service work, Type YMW-1A Unimeter is a 20,000 ohms per volt multi-range instrument with a single rotary selector switch controlling all operations and ranges. Specifications include resistance coverage of 1 ohm to 20 megohms, ac and dc voltage from 0-1000 volts, current from 0 to ½ amp., and output from —4 to 62 db.—*Electronics Dept., General Electric Co., Syracuse, N. Y.*

CAPACITANCE METER

(Use Inquiry Card, Mentioning No. 310)

Designed for measuring small capacitances such as between tube socket contacts, Model 202 instrument has four scales for measurements between 0-.01, 0-2.0, 0-5.0 and 0-10.0 mmfd. Capacity-to-ground effects do not affect the accuracy of the instrument, which may also be used to measure the inductance of coils. Consisting of a 100 kc oscillator in conjunction with a vacuum tube voltmeter the instrument is guaranteed to be within 2% of full scale on all capacity ranges. It operates on 110-120 v., ac.—*Maida Development Co., Box* 588, *Erie, Pa.*



FREQUENCY GENERATOR

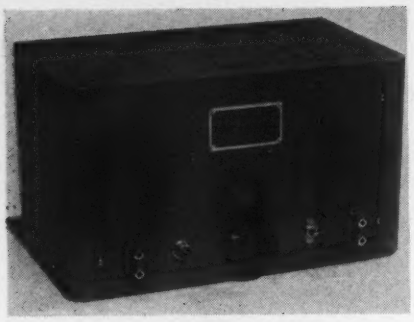
(Use Inquiry Card, Mentioning No. 311)

Containing 12 preset frequencies chosen to cover 95% of radio receiver sets in use, model 200 spot frequency generator provides 6 flip switches for the selection of frequencies between 175 kc and 20 mc. An electron coupled circuit insures stability and double shielding provides for low leakage. A switch permits modulated, unmodulated or separate audio voltage. The unit is equipped with fine and coarse output controls. It is ac-operated.—*Electronic Mfg. Co.,* 714 *Race St., Harrisburg, Penn.*

SPOT ENAMEL STRIPPER

(Use Inquiry Card, Mentioning No. 312)

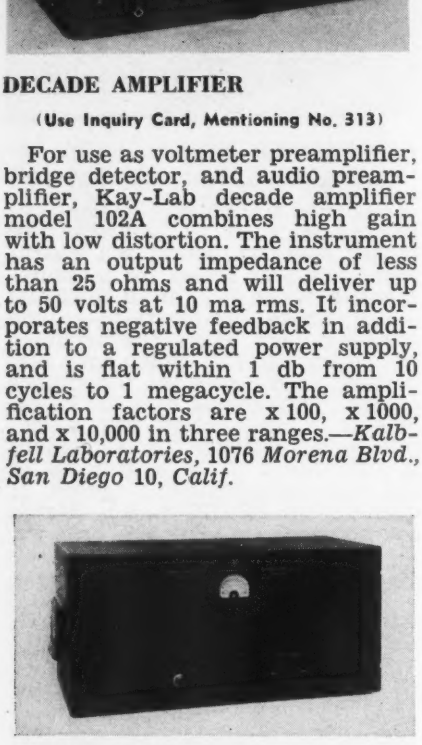
Developed for removal of synthetic enamel and other coatings on large parts that cannot be immersed in a stripping solution, Enthone enamel stripper S-45 is a slightly viscous liquid that can be brushed, sprayed or applied by dipping. It contains a non-waxy evaporating retardent that assures completion of the stripping action. Stripping is accomplished by wrinkling.—*Enthone, Inc., Dept. EI,* 442 *Elm St., New Haven, Conn.*



DECADE AMPLIFIER

(Use Inquiry Card, Mentioning No. 313)

For use as voltmeter preamplifier, bridge detector, and audio preamplifier, Kay-Lab decade amplifier model 102A combines high gain with low distortion. The instrument has an output impedance of less than 25 ohms and will deliver up to 50 volts at 10 ma rms. It incorporates negative feedback in addition to a regulated power supply, and is flat within 1 db from 10 cycles to 1 megacycle. The amplification factors are x 100, x 1000, and x 10,000 in three ranges.—*Kalbfell Laboratories,* 1076 *Morena Blvd., San Diego* 10, *Calif.*



CAPACITANCE RELAY

(Use Inquiry Card, Mentioning No. 314)

Relay operation and panel meter indication of capacitance changes for the control of external devices is provided by Model DD-2O capacitance relay, which has adjustable sensitivity to suit requirements. A change of .01 mmfd is discernible on the meter, while relay operation is obtained with changes of 0.05 mmfd or more. For relay operation a 115-volt, ac, closed or open circuit is provided. The instrument has an electronically regulated power supply and operates from 115-volt, 60 cycle, ac. Applications include the limiting of linear motion, safety control for machine operators, control of machinery and illumination, etc.—*Browning Laboratories, Inc., Winchester, Mass.*

FM & TELEVISION LEAD-IN

(Use Inquiry Card, Mentioning No. 315)

Intended to connect antennas with FM or television receivers for minimum transmission loss these lead-in cables are available in 3 sizes in impedances of 100 and 300 ohms. The required type size cable depends on the specific application, the 300 ohm line having a capacitance of 5.8 mmfd per ft. Polyethylene insulation of the low-loss cables, makes them resistant to chemicals and weatherproof.—*Specialty Div., General Electric Co., Wolf Street Plant, Syracuse, N. Y.*

ANNOUNCEMENT

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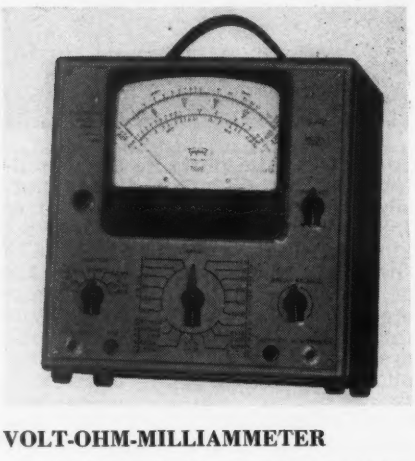


VOLT-OHM-MILLIAMMETER

(Use Inquiry Card, Mentioning No. 316)

Useful for FM and television work, Triplett Model 2450 electronic volt-ohm-milliameter is equipped with a 6-in. meter and provides stability within a line variation range of 90 to 130 volts. Specifications include ac and dc volts from 0-1000 in 6 ranges, dc milliamperes from 0-1000 in 6 ranges, ohms from 0 to 1000 megohms in 6 ranges, and capacity to 500 mfd in 5 ranges. —*The Triplett Electrical Instrument Co., Bluffton, Ohio.*

CALCULATING MACHINE

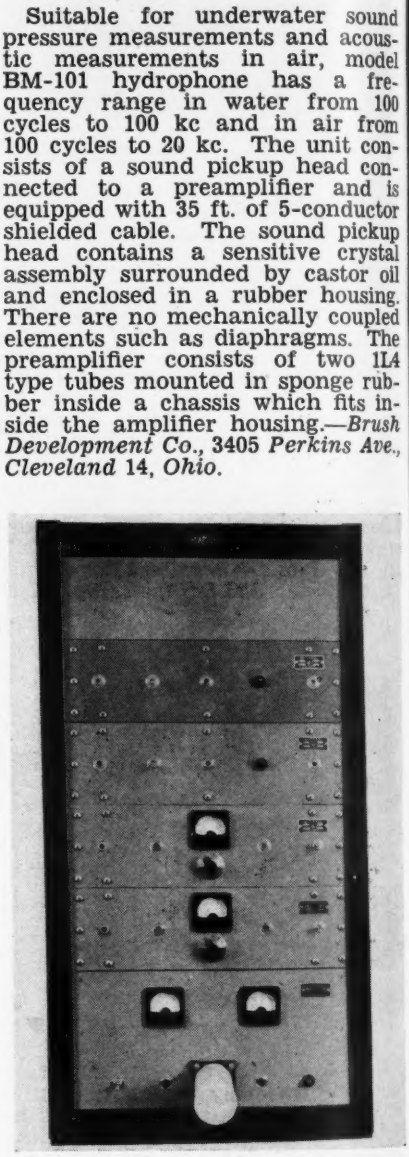
(Use Inquiry Card, Mentioning No. 317)

Weighing only 12 lbs. and of particularly rugged construction, the Original-Odhner calculators, manufactured in Sweden, are again available for use in multiplication, division, square root, percentage, geometrical and engineering problems. The portable units are lever-set and hand-operated. A new back transfer device automatically transfers the result from previous operations to the setting board, thus saving time required for resetting.—*Distributed by Ivan Sorvall,* 210 *Fifth Ave., New York* 10, *N. Y.*

SOUND PRESSURE STANDARD

(Use Inquiry Card, Mentioning No. 318)

Suitable for underwater sound pressure measurements and acoustic measurements in air, model BM-101 hydrophone has a frequency range in water from 100 cycles to 100 kc and in air from 100 cycles to 20 kc. The unit consists of a sound pickup head connected to a preamplifier and is equipped with 35 ft. of 5-conductor shielded cable. The sound pickup head contains a sensitive crystal assembly surrounded by castor oil and enclosed in a rubber housing. There are no mechanically coupled elements such as diaphragms. The preamplifier consists of two 1L4 type tubes mounted in sponge rubber inside a chassis which fits inside the amplifier housing.—*Brush Development Co.,* 3405 *Perkins Ave., Cleveland* 14, *Ohio.*



DIVERSITY RECEIVING SYSTEM

(Use Inquiry Card, Mentioning No. 319)

The FSR receiver, FSL limiter and FSK keyer comprise the National frequency shift diversity receiving equipment. Use of multiple FSR's and FSL's makes possible space or frequency diversity or both. Especially suitable for teletypewriter operation, the frequency shift receiver operates on a fixed crystal controlled frequency in the 2-20 mc range. The output of the receiver feeds to the limiter, where it is amplified, limited, discriminated and balanced keying voltages are supplied to the frequency shift keyer, which amplifies the pulses sufficiently to actuate a printer. The system operates on 115 volts, 50 cycle, ac.—*National Co. Inc., Malden, Mass.*

French Firm Licensed by CBS

The first license for foreign manufacture of ultra-high frequency color television transmitting equipment and receivers under inventions of the Columbia Broadcasting System has been granted to Sadir-Carpentier, French communications manufacturing firm. Simultaneously, M. Rene Deschamps, Director General of Sadir-Carpentier, revealed his company will prepare definite proposals to French government authorities for establishment of a national color television broadcasting system in France.

A group of its engineers, led by M. Jean A. Widemann, in charge of the Television Department at Sadir-Carpentier, are due in the United States early this Spring to make a detailed study of CBS technic.

The Sadir-Carpentier firm is the result of an amalgamation in 1943 of the Societe Anonyme des Industries Radioelectriques and Atelier J. Carpentier. The former manufactured radio devices; the latter, electric meters and navigational equipment. The merged organization presently is concentrating on radio equipment and precision machinery in several factories and laboratories in the Paris area and at Nantes.

Sadir-Carpentier is the fourth major concern licensed by CBS under its color television patents. The other three, all in the United States, are Westinghouse Electric Corp., Federal Telecommunications Laboratories, Inc., affiliate of the International Telephone & Telegraph Corporation, and Bendix Radio Division of Bendix Aviation Corporation.

Sylvania to Produce Radar for Ships

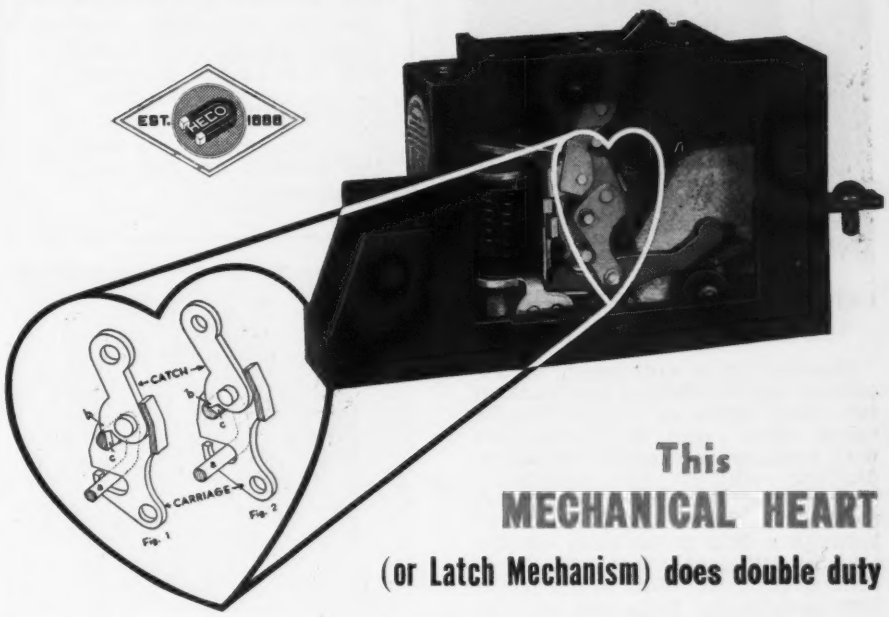
Sylvania Electric plans to produce, distribute and service commercial marine radar systems originally developed by A. C. Cossor, Ltd., British firm and an affiliate of Sylvania. Orders from more than 45 shipping companies for from one to twenty Cossor radars similar to the installation now on the Queen Elizabeth are on the books.

THIS

HEINEMANN

MAGNETIC CIRCUIT BREAKER

bares its Mechanical Heart



This MECHANICAL HEART (or Latch Mechanism) does double duty

No. 1. *It opens breaker with least mechanical delay.*

When the armature engages the lower leg of the lock (a) it rotates the lock enabling the tooth of the catch (b) to pass through the cut portion of the lock (c), thereby breaking the toggle and releasing the contacts which are under heavy spring pressure. *Of all known latches, this mechanism operates with the least amount of friction.*

No. 2. *It opens breaker independent of handle operation.*

The relative position of the catch to the carriage remains the same as in Fig. 1 whether the handle is in the "on" position or turned to the "off" position, when the contact is broken manually. The latch collapses only under overload or short circuit conditions—*and it does that even if the handle is purposely held in the "on" position.* Fig. 2 shows the latch on its way to the collapsed position.

HEINEMANN ELECTRIC CO.

Established 1888

149 PLUM STREET — TRENTON, N. J.

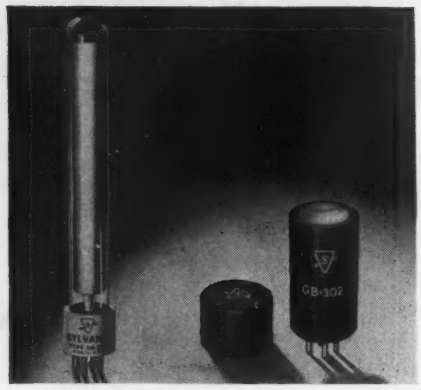
TERMINALS
for
ELECTRIC WIRES

SMALL METAL STAMPINGS
in accordance with your blueprints

PRECISION PARTS
from Modern Equipment

PATTON-MacGUYER CO.
17 VIRGINIA AVENUE — PROVIDENCE 5, R. I.

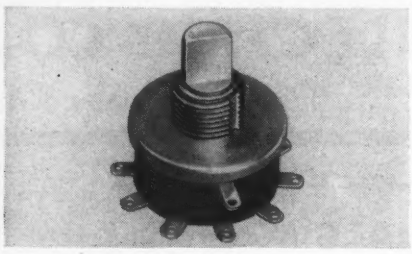
Parts for Design Engineers



GEIGER-MUELLER TUBES

(Use Inquiry Card, Mentioning No. 320)

Suitable for a wide range of laboratory and industrial applications, two new types of Geiger-Mueller tubes when used in conjunction with auxiliary apparatus detect radiations emitted by radioactive substances. The beta-ray tube admits the high speed electrons through a thin metal alloy window and is sufficiently compact to be used as probe in many applications. The gamma-ray tube has no window and is primarily designed for detection of gamma rays emitted by radioactive sources, but can also be used for cosmic rays in coincidence work. Both tubes are of the non-self-quenching type and are for use with a standard quenching circuit, such as the Neher-Pickering. The gas-filled units have good stability and uniformity. They are supplied with standard medium 4-pin tube bases for quick interchangeability.—*Sylvania Electric Products, Inc.*, 500 *Fifth Ave., New York* 18.



MINIATURE SWITCH

(Use Inquiry Card, Mentioning No. 321)

Suitable for any circuit up to 5 amps. and breaking up to 1 ampere at 110 volts, the series 5000 Roto switch features 360° rotation in clockwise or counterclockwise direction. Measuring only ¾ in. in diameter and $^{13}/_{32}$ in. in depth, the switch has a contact pressure of 2½ lbs and is available with 10 positions in shorting and non-shorting types. Shafts for knob or screw adjustment are provided.—*Grayhill*, 1 *North Pulaski Road, Chicago* 24, *Ill.*

ANNOUNCEMENT

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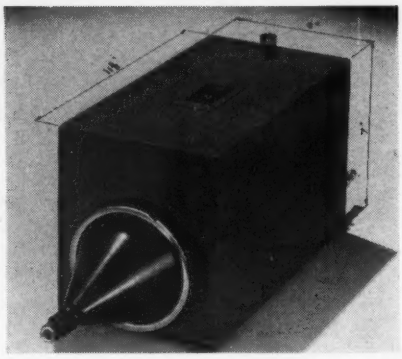


VHF-UHF LOAD RESISTOR

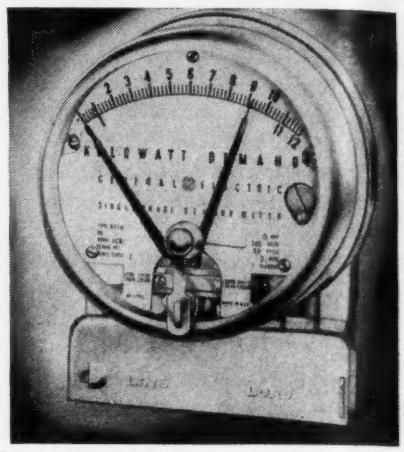
(Use Inquiry Card, Mentioning No. 322)

When low VSWR coaxial loads are required for laboratory and production tests model 69 Thermaline load resistor offers a constant resistance of 51.5 ohms through a frequency range from dc to well over 1000 mcs. Without auxiliary cooling the unit will dissipate 300 watts and connected to tap water supply will handle 1 kw with a flowrate of ½ gal. per minute. At frequencies below 100 mc, the rf resistance is within 2% of the dc resistance with a small reactance component present. Dc resistance is held to ± 5%. Typical VSWR's range from 1.02 at 100 mcs to 1.04 at 500 mcs.—*Bird Electronic Corp.*, 1800 *E. 38th St., Cleveland* 14, *Ohio.*

THERMOCOUPLE

(Use Inquiry Card, Mentioning No. 323)

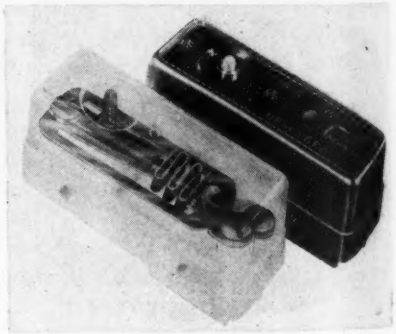
Better heat treating can be obtained at reduced cost with this new thermocouple, which can be used with any make pyrometer, and is supplied with No. 8 ga. standard chromel alumel or iron constantan element. Closer temperature control is obtained by use of ⅞ od drawn inconel protecting tube which fits thermocouple closely. The element can be replaced by loosening two screws. The units are available in all standard lenghts from 12 in. to 48 in., in multiples of 6 in., and 60 to 144 in. in steps of 12 in.—*Arklay S. Richards Co., Inc.*, 17 *Winchester St., Newton Highlands* 61, *Mass.*



WATT-DEMAND METER

(Ues Inquiry Card, Mentioning No. 324)

Operating on the "direct-heat" principle based on use of temperature-sensitive, bi-metallic spirals that act as their own heaters. Type HI-1 thermal watt-demand heater has inherently greater operating torques, and increased life and accuracy. Maximum demand is indicated by a black pointer, which is pushed up-scale by a red pointer. Units are provided with a manually-operated re-set device. The scale conforms to EEI and AEIC standards.—*General Electric Co., Schenectady* 5, *N. Y.*



SNAP-ACTION SWITCH

(Use Inquiry Card, Mentioning No. 325)

To meet a need of millibreak switches with uniform characteristics in mass production of precision apparatus this snap-action switch makes possible installation of switches without need for individual adjustment of associated apparatus. Contacts are silver, laminated on copper, with the moving contact having low mass for minimum contact bounce. One mounting hole is elongated for convenience in assembly. The SPDT units are rated 15 amps. at 125 V., 5 amps. at 250 V. and ½ hp from 115-460 V., 60 cycles, ac.—*Unimax Switch Corp., Subs. of W. L. Maxon Corp.*, 460 *W.* 34 *St., New York* 1.

LET THESE WAA DISTRIBUTORS HELP YOU

Save with surplus

The War Assets Administration has appointed a representative group of competent well established distributors to help dispose of war-surplus electronic tubes and equipment. We suggest that you get in touch with the distributor nearest you. He will know the items available and how they can aid in solving your electronic problems.

ELECTRONICS DIVISION
OFFICE OF AIRCRAFT DISPOSAL

WAR ASSETS ADMINISTRATION

425 Second St., N.W. Washington 25, D. C.

Here is an up-to-date list of WAA approved distributors.

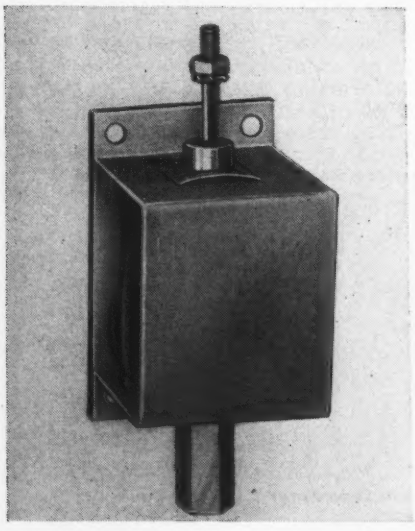
BOSTON, MASS.	
Automatic Radio Mfg. Co., Inc.	122 Brookline Ave.
Technical Apparatus Co.	165 Washington St.
BUCHANAN, MICH.	
Electro-Voice, Inc.	Carroll & Cecil Sts.
CANTON, MASS.	
Tobe Deutschmann Corp.	863 Washington St.
CHICAGO, ILL.	
American Condenser Co.	4410 Ravenswood Ave.
Majestic Radio & Television Corp.	125 W. Ohio St.
EMPORIUM, PENN.	
Sylvania Electric Products, Inc.	
FORT WAYNE, IND.	
Essex Wire Corp.	1601 Wall St.
LOS ANGELES, CALIF.	
Cole Instrument Co.	1320 S. Grand Ave.
Hoffman Radio Corp.	3761 S. Hill St.
NEWARK, N. J.	
Standard Arcturus Corp.	99 Sussex Ave.
Tung-Sol Lamp Works, Inc.	95—8th Ave.
NEW YORK, N. Y.	
Communication Measurements Laboratory	120 Greenwich St.
Electronic Corp. of America	353 W. 48th St.
Emerson Radio & Phonograph Corp.	76—9th Ave.
Hammarlund Mfg. Co., Inc.	460 W. 34th St.
Newark Electric Co., Inc.	242 W. 55th St.
Raytheon Mfg. Co.	60 E. 42nd St.
Smith-Meeker Engineering Co.	125 Barclay St.
SALEM, MASS.	
Hytron Radio & Electronics Corp.	76 LaFayette St.
SCHENECTADY, N. Y.	
General Electric Co.	Bldg. 267, 1 River Rd.
WASECA, MINN.	
E. F. Johnson Co.	206—2nd Ave., S. W.

946

HIGH POWER FM TUBE

(Use Inquiry Card, Mentioning No. 326)

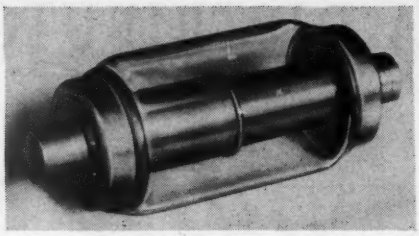
Meeting the specific requirements of FM transmission service in the 88 to 108 mc band with a maximum output up to 110 mc, the 7C27 power triode provides 10 kw output when used in pairs in the final amplifier stage. Radial cooling fins and use of pure copper anodes assures efficient forced-air cooling with an airflow of 175 cu. ft. per minute. Low filament-to-plate capacitance makes the 7C27 adaptable in grounded-grid circuits. Maximum plate dissipation of the tube is 3000 watts, filament voltage 16 volts, and filament current 28.5 amps.—*Federal Telephone and Radio Corp., Newark, N. J.*



AC SOLENOID

(Use Inquiry Card, Mentioning No. 327)

Suitable for either push or pull the 104S8 ac solenoid utilizes high grade silicon steel to produce a solid iron frame with a mechanically well guided moving core. The unit is fully iron clad through the addition of side plates to the formed frame. On a continuous duty basis it has a work output of 1½ in.-lbs. This output is obtainable at 1 in. stroke or less.—*Automatic Switch Co., 41 East 11 St., New York, N. Y.*



VACUUM CAPACITOR

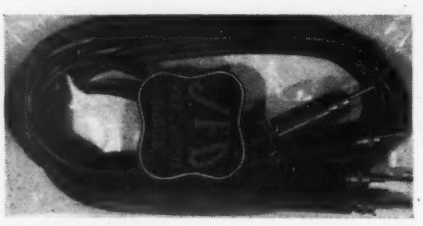
(Use Inquiry Card, Mentioning No. 328)

Rated 30 kv peak voltage at 10 mc with lower ratings at lower frequencies the VC-50 vacuum capacitor has a capacitance of 50 mmfd ±2%. Maximum rms current ratings of 65 amps at 10 mc and 40 amps at 60 mc are based on a maximum glass to metal seal temperature of 150° C. Internal losses decrease as the frequency decreases, since they are largely ohmic.—*Amperex Electronic Corp., 25 Washington St., Brooklyn, N. Y.*

VHF TRANSMITTER TUBE

(Use Inquiry Card, Mentioning No. 329)

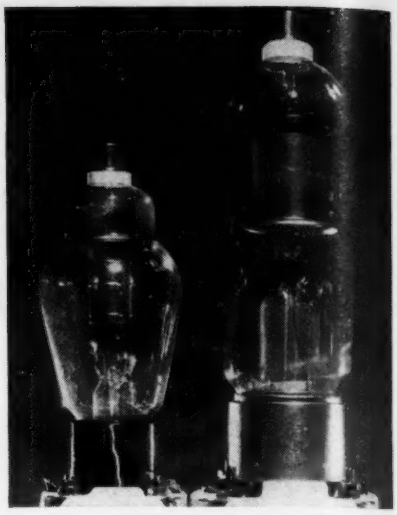
The type GL-5513 medium power triode has been developed for operation in the vhf range to 220 mc in connection with television and FM transmission and dielectric heating applications. In Class C telegraph service it will deliver 2 kw with a power gain of 10, while as a Class B video amplifier it is rated at 1 kw at an approximate power gain of 8. Maximum anode potentials are 4,000 volts for Class C and 3,000 volts for Class B; the filament draws 32 amperes at 6.3 volts.—*General Electric Co., Electronics Dept., Thompson Road, Syracuse, N. Y.*



TEST LEADS

(Use Inquiry Card, Mentioning No. 330)

Containing 15 different test leads made with fiber and cast phenolic prod handles, this new line uses No. 18 soft-drawn copper-wire, insulated with flexible rubber. End fittings may be phone tips, phono needle points, spade lugs, alligator clips, banana plugs or the new elbow angle tips. The fittings are made of chromium-plated brass.—*JFD Mfg. Co., 4117 Fort Hamilton Parkway, Brooklyn 19, N. Y.*



MERCURY VAPOR RECTIFIERS

(Use Inquiry Card, Mentioning No. 331)

Two new mercury vapor rectifiers, Eimac Type 866A and 872A, directly interchangeable with tubes of similar ratings have been brought out. Type 866A operates with 2.5 filament volts, a peak inverse voltage as high as 10,000 volts, and a max. average plate current of .25 amps. The 872A has a 5-volt filament and carries a max. peak inverse rating of 10,000 volts, and max. average current rating of 1.25 amps.—*Eitel-McCullough, Inc., 1018 San Mateo Ave., San Bruno, Calif.*

TRANSMISSION LINE

(Use Inquiry Card, Mentioning No. 332)

Suitable as lead-in for connecting antenna to receiver and transmitter, No. 14-023 Polyethylene twin-lead, heavy-duty transmission line has superior loss characteristics and is highly resistant to moisture and most solvents. The conductors, made up of seven strands of No. 21 copper wire will carry 1 kw of energy, even when mismatched. The line has an impedance of 75 ohms.—*American Phenolic Corp., Chicago 50, Ill.*

FIBERGLAS TUBING

(Use Inquiry Card, Mentioning No. 333)

Designed for applications where fire or conducted heat is a hazard Ben-Har specially treated Fiberglas tubing will not react to heat conducted through the wire and will not support combustion even in direct contact with flame. The tubing is available in Grade "A" with dielectric strength of 5000 to 7000 volts and grade "B" with rating of 2500 to 4000 volts. Standard length is 36 in. and standard sizes are available in black, red and yellow. —*Bentley, Harris Mfg. Co., Dept. P5, Conshocken, Pa.*

TELEVISION

Synchronizing and Picture Generator with Monitoring Oscilloscope

DESIGNED BY R. E. DE COLA

TELEQUIP T.S.G. 100 Synchronizing Generator and Monitor

Designed for application in television transmitting plants, and for development research, engineering and production testing in television receiver manufacture. Produces signals having all the necessary synchronizing, blanking and driving pulses required for operation of Iconoscope and Kinoscope units. In substantial agreement with basic FCC-RMA standards. Rack unit includes one Timer Unit, one Shaper Unit, and one Monitoring Oscilloscope (each with electronically regulated power supply). Timer unit produces the three basic output signals from which all synchronizing pulses are derived. Shaper Unit forms, locates and mixes the required signal by processes of clipping, integrating and differentiating. Monitoring Oscilloscope provides a short 7-inch electrostatic deflection cathode ray tube for display.

•

We look forward to meeting you and demonstrating this equipment at the I.R.E. SHOW, MARCH 3-6 Grand Central Palace New York, N. Y. Booth 7-D

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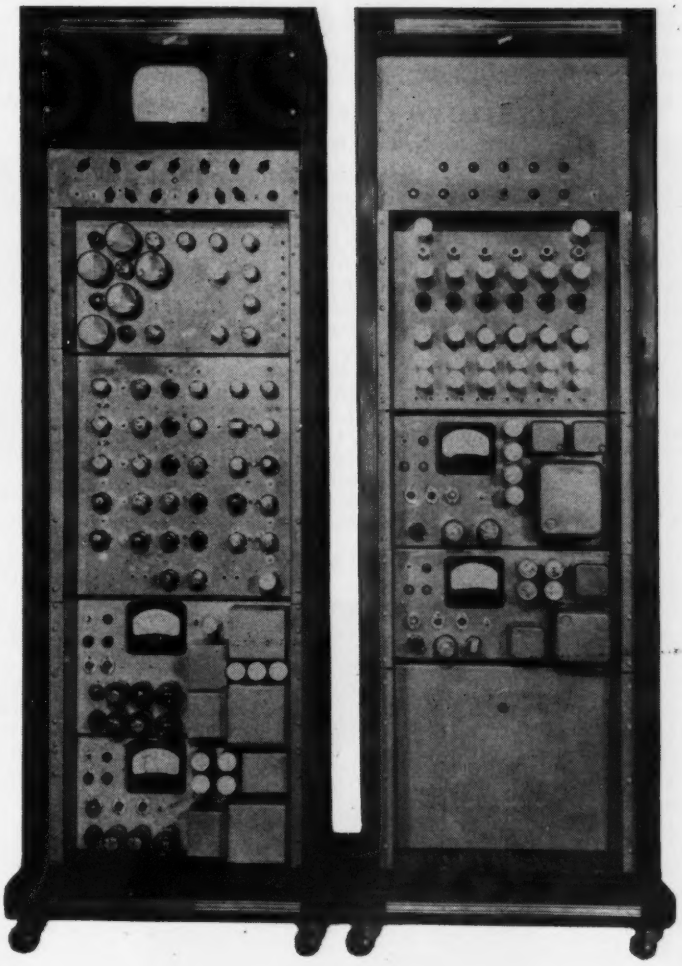


TELEQUIP T.M.G. 100 Monoscope and Picture Generator

Supplies a composite signal suitable for external distribution, obtaining its driving, synchronizing and pedestal signals from the Synchronizing Generator. Separate controls are available for the amplitude adjustment of the synchronizing signals, pedestals and video signals.

The Monoscope Picture Generator contains four electrical units as follows: Monoscope Unit, Distribution Unit and Regulated Power Supplies for Monoscope and Distribution Units.

The Monoscope Unit contains scanning circuits, mixers and video amplifier. Type 2F21 RCA monoscope tube is used. The video amplifier response is substantially flat to 6 MC.

The Distribution Unit has all output signals: Composite picture signal, Kinoscope sync pulses, Iconoscope or Monoscope pedestals, Kinoscope pedestals, Iconoscope or Monoscope vertical and horizontal driving pulses.

All signals appear across approximately 70 ohms and have an amplitude of 2 volts, peak to peak. All signals are available in both positive and negative polarities. Signal terminals at rear of unit. Cable storage compartment at bottom of rack.

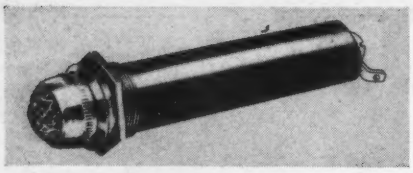
Telequip T.S.G.M. 100 Television Synchronizing Generator with Monoscope using same timer, same Monoscope and same shaper as described above available in one rack for certain applications. Substantially meets F.C.C. and R.M.A. requirements.

You are invited to write for a detailed description of the TELEQUIP Synchronizing Generator and Monitor . . . as well as for data covering the TELEQUIP Monoscope Picture Generator and Distribution Unit. For television testing apparatus, look to TELEQUIP, specialists in the design and manufacture of advanced Television Equipment.

TELEQUIP RADIO COMPANY

1901-07 S. WASHTENAW AVE. CHICAGO 8, ILL.

DESIGNERS • MANUFACTURERS *of* TELEVISION *and* COMMUNICATIONS EQUIPMENT • ELECTRONIC PRODUCTS



FLASHING PANEL LAMP

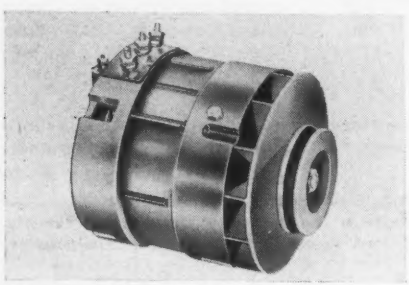
(Use Inquiry Card, Mentioning No. 334)

An effective warning light for dangerous conditions of temperature, pressure, or extremes of current or voltage, the Blink-O-Light flashing signal panel lamp is a single-unit assembly slightly over 3½ in. in length, which does not require any more space than the ordinary panel lamp. Standard models are available for 6, 12, and 28 volts, and can also be adapted for 115 V. ac. The units may be equipped with "push-to-test" buttons for operation checking.—*Jersey Technical Enterprises, 45 Clinton St., Newark 2, N. J.*

HERMETIC SEALS

(Use Inquiry Card, Mentioning No. 335)

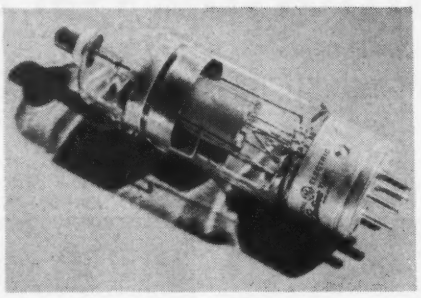
Regardless of specifications for shape, size and weight, single terminals or multiple headers, any requirements can be met for the production of hermetic seals in a combination of new metal and glass. Terminals in the headers may be arranged with a minimum of spacing in any pattern or combination of voltage ratings. Hermico-glass headers possess a matched coefficient of expansion and have a resistance over 10,000 megohms between body and terminals or between terminals.—*Hermetic Seal Products Co., 414-418 Morris Ave., Newark 3, N. J.*



AC GENERATOR

(Use Inquiry Card, Mentioning No. 336)

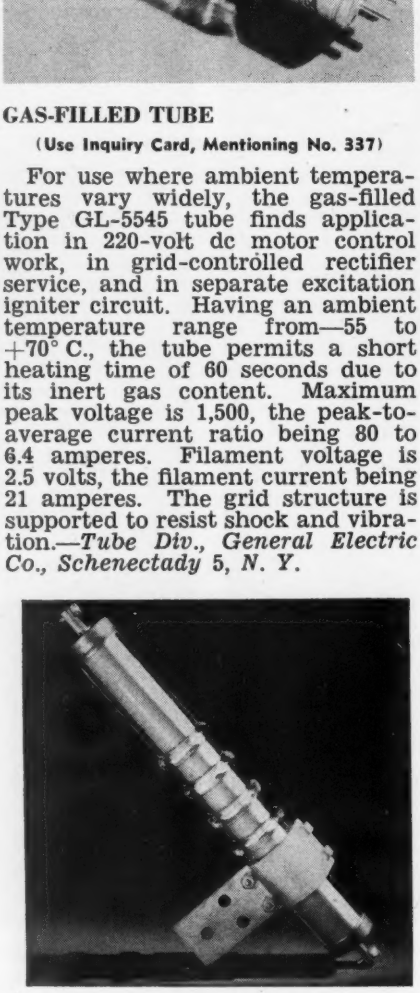
Overcoming the problem of undercharged batteries for 2-way car radio systems cruising at slow speeds such as police and fire department vehicles, taxicabs, etc., the 6-volt Leece-Neville ac generating system delivers 25 to 35 amps. at idle engine speed and 60 amps. from 15 miles per hour to top speed. Consisting of alternator, voltage regulator and rectifier the unit has no commutator or rotating armature winding and weighs 40 lb. The 12-volt version, weighing only 42 lb., delivers 100 amps. at idle or full speed. Due to absence of sparking, radio, noise is kept to a minimum.—*Leece - Neville Co., Cleveland 14, Ohio.*



GAS-FILLED TUBE

(Use Inquiry Card, Mentioning No. 337)

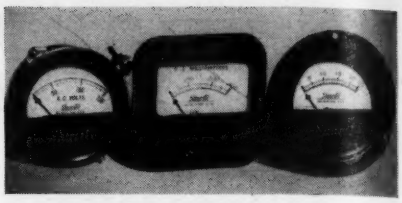
For use where ambient temperatures vary widely, the gas-filled Type GL-5545 tube finds application in 220-volt dc motor control work, in grid-controlled rectifier service, and in separate excitation igniter circuit. Having an ambient temperature range from—55 to +70° C., the tube permits a short heating time of 60 seconds due to its inert gas content. Maximum peak voltage is 1,500, the peak-to-average current ratio being 80 to 6.4 amperes. Filament voltage is 2.5 volts, the filament current being 21 amperes. The grid structure is supported to resist shock and vibration.—*Tube Div., General Electric Co., Schenectady 5, N. Y.*



HV COUPLING CAPACITOR

(Use Inquiry Card, Mentioning No. 338)

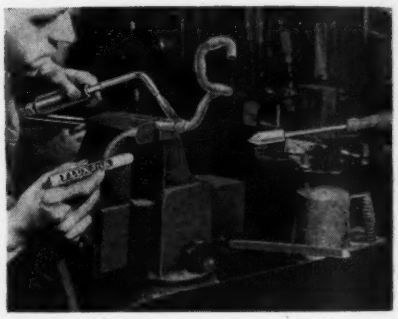
The problems of coupling subscriber's telephone equipment to existing 7200 volt ac distribution lines has been solved by means of this high voltage coupling capacitor, which is designed to withstand 10 test impulses of 95 kv. High voltage surges, even lightning discharges on the line, are handled by these units without breakdown. In size and weight the Sprague coupling capacitors are 1/10 of other types in this service. Units now in production have a value of .002 mfd and are rated 8,700 volts at 60 cycles ac.—*Sprague Electric Co., North Adams, Mass.*



AC, DC METERS

(Use Inquiry Card, Mentioning No. 339)

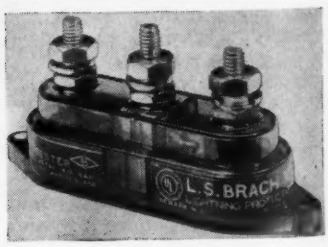
A complete line of AC and DC, 2 in. and 2½ in. panel meters in round and rectangular case types is available in ammeters, milliammeters, voltmeters, and resistance meters. All dc meters are polarized-vane, solenoid units, while the AC meters are of the double-vane, repulsion type. Both types are accurate within 5%. The units are flush-mounting and of black enameled brass construction. Zero adjusters are supplied, when required, on two of the dc case types.—*Shurite Meters, 61 Hamilton St., New Haven 8, Conn.*



SOLDERING STICK

(Use Inquiry Card, Mentioning No. 340)

Eliminating waste by permitting just enough flux for the joint, Flux-Stik is a soldering flux molded into stick form, is non-acid, yet thoroughly and quickly dissolves the oxides of metals. No preliminary cleaning of the metal is necessary; the stick is non-running and covers only the joint and vicinity. It can be applied equally well to hot or cold metal.—*Lake Chemical Co., 607 N. Western Ave., Chicago 12, Ill.*



LIGHTNING ARRESTER

(Use Inquiry Card, Mentioning No. 341)

Making use of a highly sensitive rare gas tube in multiple with heavy conductive plates, the revised model Vis-O-Glow lightning arrester is for radio use and has Underwriters' Lab. approval. The air gap plates do not function except when the current enters the antenna in excess of the capacity of the tube. The casing has a slow-burning inhibiter.—*L. S. Brach Mfg. Corp., Newark, N. J.*

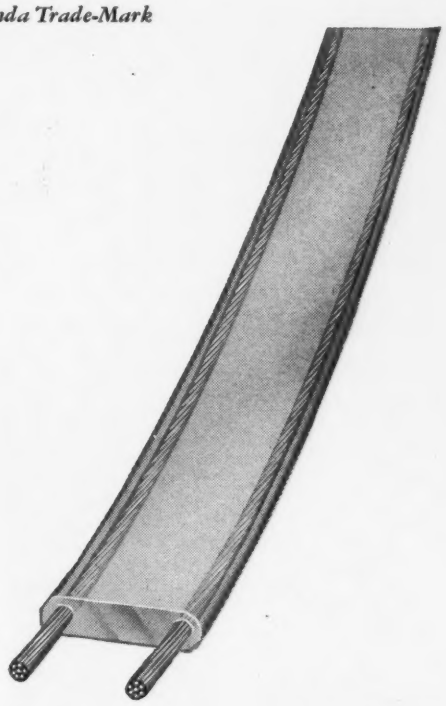
Anaconda

type ATV* FM and television lead-in lines

THE WELL BALANCED DESIGN of conductors and dielectric in Anaconda Type ATV lead-in lines fulfills the exacting requirements of wide-band reception. For FM and television reception, these lead-in lines minimize the effects of attenuation and impedance mismatch—providing maximum freedom from distortion.

Anaconda offers to the industry a wide selection of Type ATV lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and 150 ohms shielded—each designed for a particular application. 47441

An Anaconda Trade-Mark



Now you can choose!

THIS OR THIS

For Uniform Transmission Characteristics Use Anaconda High-Frequency Cable

Make Anaconda your headquarters for high-frequency cables. Write for a useful folder containing electrical and physical characteristics of all Anaconda coaxial cables. Also, ask for a bulletin on the characteristics of Type ATV lead-in lines. Address: Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y.

ANACONDA from mine to consumer

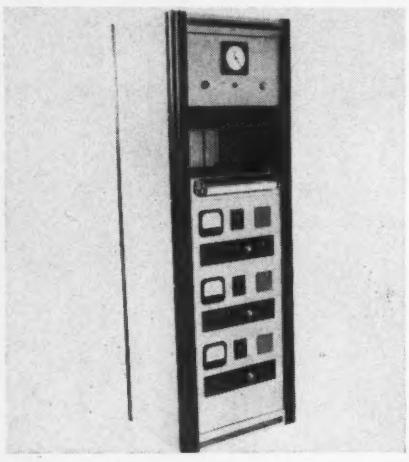
ANACONDA WIRE AND CABLE COMPANY

Communications Components

INTER-COMMUNICATING SYSTEM

(Use Inquiry Card, Mentioning No. 342)

Operating efficiently as far as 2000 ft. apart between stations, the Model P-359 selective master station handles from 1 to 5 substations. It contains a 3-tube amplifier providing 1 watt output, and is equipped with a 5-in. speaker. The master station permits communication with each of five substations, but substations cannot call each other.—*Worner Electronic Devices, Rankin, Ill.*



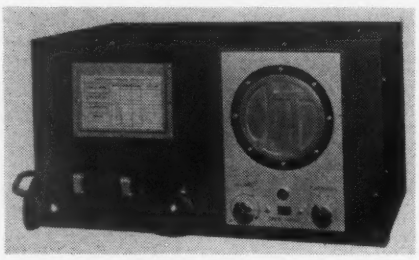
DISTRIBUTION AMPLIFIER

(Use Inquiry Card, Mentioning No. 343)

Capable of supplying 2,000 subscriber locations Type T-3-A distribution amplifier is a complete studio sound distribution system for transmission of 3 independent programs on 2 telephone channels. The equipment includes: An automatic timer and selector panel which will turn on and off complete equipment for any pre-set period and will select any number or groups of records at pre-determined intervals. A dual speed transcription type turntable will play 16 in. transcriptions, or 10 and 12 in. records. Two high fidelity grouping amplifier channels are provided. A fully automatic emergency amplifier will take over instantaneously upon failure of the grouping amplifiers. The equipment is for use on 105 to 125 volt, 60 cycle, ac and has been approved by telephone companies. — *Tel-O-Matic Products, Clifton, N. J.*

ANNOUNCEMENT

For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 98 in this issue, and *Identify the product by the number assigned to it.*



MARINE RADIOTELEPHONE

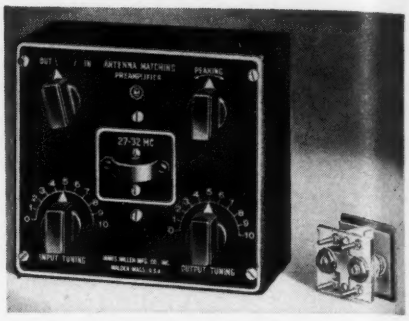
(Use Inquiry Card, Mentioning No. 344)

Radiotelephone model 102 for average cruising ranges is a crystal-controlled 10-watt receiver-transmitter combination that can be used without change on either 6 or 12 volts. The unit provides four channels for frequencies between 2 and 11 mc. It is suitable for table or shelf mounting.—*Jefferson-Travis, Inc.*, 380 *Second Ave., New York* 10.

OUTDOOR HAND MICROPHONE

(Use Inquiry Card, Mentioning No. 345)

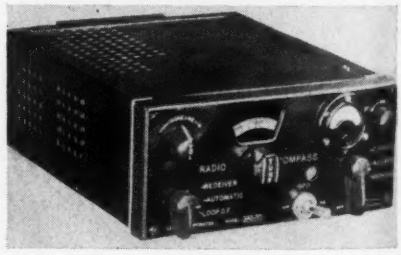
Suitable for public address, paging and call systems and for home recorders model 20X hand microphone features a Metalseal crystal which withstands humidity conditions not tolerated by ordinary crystals. Response range is from 50 to 7,000 cycles with an output level of 54 db below 1 volt/dyne/cm^2. The unit can be used with any standard amplifier having a high impedance input. The unit is supplied with 7 ft. of cable and spring type protector to reduce cable wear.—*Turner Co., Cedar Rapids, Iowa.*



MATCHING PREAMPLIFIER

(Use Inquiry Card, Mentioning No. 346)

Combining a broad-band preamplifier and an electronic impedance matching device in a single unit, Millen Model No. 92101 is designed for the 6, 10, and 20 meter amateur bands, separate coils being available for each band. The gain of the device is above 30 db with most receivers and is greater, when the mismatch between antenna and receiver is more serious. The unit, once it is tuned, automatically matches receiver to antenna. A 6AK5 miniature tube serving as broad-band rf amplifier provides a gain in the order of 30 db, in addition to the gain by matching.—*James Millen Mfg. Co.*, 150 *Exchange St., Malden* 48, *Mass.*



AUTOMATIC RADIO COMPASS

(Use Inquiry Card, Mentioning No. 347)

Weighing only 24 lb. the Lear model ARC-10 automatic radio compass is suitable for private aircraft, as well as the airlines. The unit is available as single or dual instrument, the latter consisting of two independent ARC-10 systems, using a single azimuth indicator. The tuner unit contains all rf circuits and is mounted on the instrument board. Frequency range is from 200 to 1750 kc in three continuous bands. A function selector switch permits automatic bearings, aural-null direction finding, or aural non-directional reception. AF circuits are housed in a remotely controlled amplifier unit. A servo unit comprises a dynamotor with associated filter and a friction drive which automatically turns a 4-in. loop in the direction of transmitter and at the same time turns pointer of azimuth indicator.—*Lear Inc., Grand Rapids, Mich.*

(*Continued on page* 132)

LATE NEWS DEVELOPMENTS

"20 Year Club" Pioneers Plan First Meeting

First meeting of the Twenty Year Club of radio broadcasting pioneers will take place on the evening of April 11th. Occasion will be a banquet celebration at the New York Harvard Club which the National Broadcasting Co. is organizing to mark the twenty-fifth anniversary of the first radio broadcast (April, 1922) by H. V. Kaltenborn, founder of the club. In connection with the banquet, there will be a business meeting of the Twenty Year Club to create a formal organization and elect officers and committees.

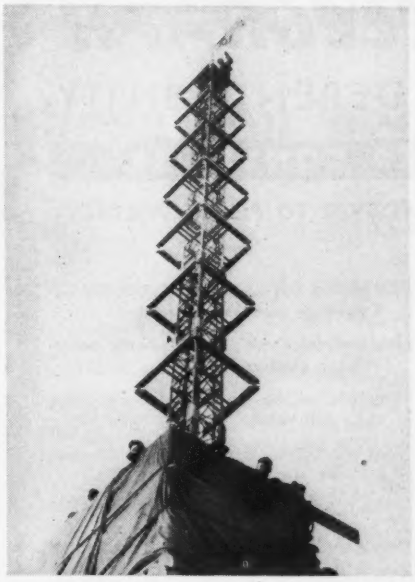
The "pioneer of pioneers" listed in the club's annual directory is Dr. Orestes H. Caldwell, editorial director of *Tele-Tech* and *Radio & Television Retailing*, who back in 1904 in Indianapolis, Ind., with Richard H. Ranger (now Colonel, U.S. Signal Corps), using a Leyden-jar discharge as source, transmitted a wireless signal which was picked up a block away by a detector consisting of a steel needle resting across two aluminum wires.

A T & T Expands Microwave Relay

The American Telephone & Telegraph Co. plans to expand its broadband high frequency radio relay system, already in operation between New York and Boston. The addition, it is planned, will link New York and Philadelphia. The New York terminal will be at 32 Avenue of the Americas and the Philadelphia terminal on Race Street. Intermediate relay stations will be located in Martinsville, N. J.: Gardenville and Wyndmoor, Pa.

Supreme to Make Transmitter Equipments

Supreme Transmitter Corp. has been formed in New York for the purpose of building standard and special transmitters for amateur, police, aviation, broadcast and other communication services. Head of the new concern and its chief engineer is Samuel L. Sack, for the past five years vice-president and chief engineer of Transmitter Equipment Mfg. Co., Inc. Other officers of the company are Leon L. Adelman, vice-president and Charles Sheer, research director and consultant. Chief designer and also secretary is Ermano Borroni, for the past seven years connected with the Federal Radio & Telegraph Co. Elmer Smith is senior project engineer, for the past three years in a similar position for Temco. Headquarters of the company are at 280 Ninth Ave., New York City.



When WTCN-FM went on the air in Minneapolis with its 3 kw Federal transmitter, it did so with the help of this 8-element square-loop antenna which gives an effective radiated power of 25 kw. Antenna is 80 ft. high, atop Foshay Tower, highest spot in area

Jefferson Electric Adds

To facilitate production and delivery of its line of transformers, ballasts and fuses, Jefferson Electric Co. has purchased a modern plant, with a floor area of approximately 250,000 sq. ft., at Fall River, Mass. The company's general offices remain at Bellwood, Ill.

Magnetic Iron Powders

The metallurgical and electronic division of the Geo. S. Mepham Corp., East St. Louis, is producing magnetic iron powders for electronic applications, by hydrogen reduction of pure iron oxides and pure oxide materials.

Motorola Gets Big Share of Cab Phones

Nine of the 15 taxicab companies who applied in December for licenses to install radiotelephone equipment have ordered their units from the Motorola Division of the Galvin Mfg. Corp. which will supply 83 of the total of 217 mobile units the companies will use as well as 9 of the 15 land stations. In addition, Motorola has also secured the order for 225 mobile units as well as 3 auxiliary test stations and 3 land stations for the highway mobile radiotelephone system to be set up by the Southwestern Bell Telephone Co., the land and auxiliary test stations to be located at Fort Worth, Tex., Oklahoma City, Okla., and Kansas City, Mo.

Altogether the 15 taxicab companies will spend a total of $114,743 for their equipment. No figures were given for the amount Southwestern Bell will spend for its project. The Commission also granted applications of four taxicab companies for the same number of land stations and 41 mobile units which will cost a total of $26,643.

Electronic Takes Tuck

Controlling interest in Tuck Electronic Corp., Jersey City, N. J., has been acquired by Electronic Apparatus, Inc., 347 Madison Avenue, New York. The Tuck organization will be continued as a division of the parent company. G. Emerson Pray, senior engineer and a director of Tuck, was elected president of that company as well as a director and vice-president of Electronic Apparatus, Inc.

British TV Slow

In England manufacturers produced a little over 2000 television receivers during the past year. By June the number was 375 and this had been stepped up to 1725 by November. Lack of transformers is holding up production, though blocks of London homes are being wired for television in anticipation of availability of sets.

FREQUENCY SHIFT TELEGRAPH

ERCO

SIMPLICITY plus DEPENDABILITY

TYPE 216-S KEYER CONVERTER

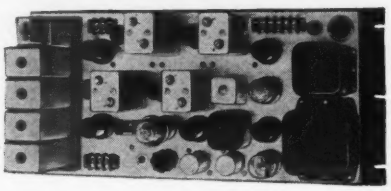
CONVERTING OUTPUT OF FSK RECEIVER TO POLAR VOLTAGE

- Calibrated self contained MARK-SPACE frequency measuring circuit.
- Internal polar relay or adjustable polar voltage outputs.
- Capable of keying speeds of better than 500 WPM.
- New MARK-SPACE rejection circuits are utilized.

TYPE 87-R RECEIVER

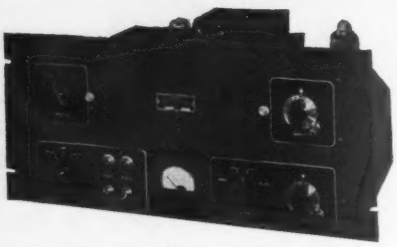
SPECIFICALLY DESIGNED FOR FSK TELEGRAPH RECEPTION

- Crystal controlled with channel change over by means of pretuned plug-in coil-crystal tray.
- Image rejection 70 DB at 4 MC and 55 DB at 20 MC.
- 20 DB signal to noise ratio at 1 microvolt input.
- Adaptable for dual or triple diversity operation.



TYPE 177-T EXCITER

FOR KEYING TRANSMITTERS BY FREQUENCY SHIFT METHOD



- Fully crystal controlled, provisions for 3 frequencies.
- MARK and SPACE frequencies both adjustable.
- Simplified and dependable operation.

Easily adapted to existing equipment.

Provides an effective 15 to 20 DB increase in circuit signal to noise ratio.

Allows use of lower powered transmitters on radio telegraph circuits.

Extends hours of operation on existing circuits due to greatly improved signal to noise ratio.

Makes automatic printer operation feasible.

ERCO RADIO LABORATORIES INC

GARDEN CITY, NEW YORK

VOLTMETER DESIGN

(*Continued from page* 83)

a pair of accurately matched tubes when the voltmeter is set for dc. The effect may be neglected except for the most precise work or where excessive line voltage variations are encountered. A line voltage regulating transformer rated at 30 volt amperes or more is recommended in case line voltage variations are troublesome.

Probably the most important consideration relates to input impedance characteristics. An analysis of the input impedance values for typical instruments commercially available reveals a wide variety of values. In many designs a probe is provided, a necessity in radio frequency measurements and of value at lower frequencies also. Here the factors to be evaluated are: Use of a balanced or unbalanced probe rectifier tube, input impedance (resistive and capacitive) value of series capacitance (on lower frequency scales), and the convenience and reliability of the probe assembly.

Double Diode Probe

In the case of a double diode probe, one diode section rectifies the input signal while the other provides a voltage to balance the initial or "contact" voltage of the signal diode caused by its normal emission current. The two diodes must be accurately matched to within 0.1 volt or less, otherwise line voltage changes will cause the initial voltages of the two diodes to change at different rates. These tubes are also tested after an aging cycle.

Experience has shown that all diodes are tested for sensitivity at 0.8 volt ac input, any showing more than $\pm 0.5\%$ variation from standard should be discarded. This is necessary to order to use predetermined fixed values of multiplier resistors and still have the ac and dc ranges match in sensitivity also, and to replace or interchange probes without recalibrating the instrument. Curves of rectification sensitivity and initial voltage for two typical probe tubes are illustrated.

The rectifier tube in the probe

(*Continued on page* 122)

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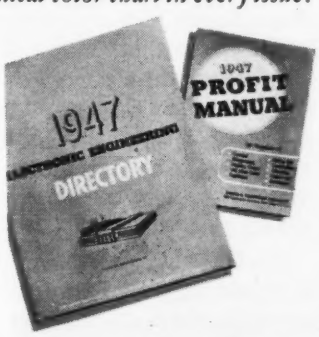
FEATURING: *How to push quality up... and costs down! A monthly industrial electronic digest of* 150 *magazines! New products and where to buy them! "Who's" doing "what" in the field! A giant two-page, technical color chart in every issue!*



MERCHANDISING *and* SERVICING

Here's your show window for radio sets, parts, phonographs, records, refrigerators, ranges, washers, vacuum cleaners, toasters, all electrical appliances and related items being sold through radio-appliance stores:

RADIO *Television* RETAILING

- **first** in net paid and total circulation: 27,100 ABC
- **first** in ABC circulation among independent radio-electrical retailers
- **first** in advertising volume and number of advertisers
- **first** in manufacturer-(and agency)-sponsored surveys
- **first** in editorial service to "Big Four" dealers *selling and servicing* radios, electrical appliances, records and accessories.

circulation:

27,100

FEATURING: *New products and where to buy them! How to make volume climb! Displays that help sell! How to meet the price-cutting trend! How to anticipate record sales! How to make credit selling work! How to make servicing pay off!* In short: *How to help the trade make more money!*

Caldwell-Clements serves every corner of the radio-electronic field with engineering handbooks, manuals, marketing data and directories! We will be glad to send manufacturers and agencies additional marketing information or a sample of this literature on written request.

Caldwell-Clements, Inc., **480 Lexington Ave., New York 17, N. Y., Plaza 3-1340**

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Conant designs and laboratory production methods permit the production of special rectifier assemblies at regular prices.
If your specifications are on file at Conant, you can be sure of receiving rectifiers which will fit the job.
Your specifications must contain the following information:

1 The maximum range of forward resistance at a definite value of current.
2 The maximum inverse current per disc.
3 The ambient temperature at which above values are to be measured.
4 A definite statement of the method used to make the above measurements and a schematic of your test circuit.

The above can then be interpreted to fit Conant test methods.

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518 City Bank Bldg., Kansas City 8, Mo.
1212 Camp St., Dallas 2, Texas
378 Boulevard N. E., Atlanta, Ga.
4018 Greer Ave., St. Louis, Mo.
1526 Ivy St., Denver, Colo.
4214 Country Club Dr., Long Beach 7, Cal.
Export Div., 75 West St., New York 6, N.Y.
50 Yarmouth Rd., Toronto, Canada

(*Continued from page* 118)

supplied with the VM-27-A or VM-27-ZC voltmeters is a 6H6. Its base is removed and the leads are wired directly into the circuit. The probe housing is molded of mica-filled phenolic with the high terminal in the nose and ground stud on the side. A 0.03 microfarad coupling condenser is connected between the nose stud and one diode. The probe responds to all frequencies without the need for greater coupling capacitance at low frequencies.

Probe Design

The probe resonates at about 250 mc with the input terminals shorted, but it may be used at even higher frequencies across low impedance circuits. This resonant rise will cause the probe to indicate 6 or 7% high at 100 mc, but the manner in which connections are made to the circuit will usually be more important at such frequencies than are its frequency characteristics.

A special high-frequency probe can be substituted generally for all measurements at frequencies above 50 mc. This probe has an input capacitance of only 0.75 mmfd (lower than any other probe available) and one-tenth the sensitivity of the standard probe, so that a direct multiplying factor can be used. The input impedance at low frequencies is determined by the diode and its associated resistors. Under most conditions of voltage and frequency, it will have a value equivalent to a resistance of 4 megohms.

The input resistance of 7 megohms for dc measurements is determined by a resistor internally shunted across the input. It is followed by a 1 megohm series resistor and an 0.01 microfarad shunt capacitor for filtering out any ac component of the applied voltage. For special tests, the 7 megohm resistor may be disconnected, provided the effects of grid current are taken into consideration.

The input capacitance (5 mmfd) is made up of a number of components, each of which contributes some loss. Considering all capacitance and loss factors, the probe input at radio frequencies is equivalent to a 5 mmf capacitor with a

power factor of 0.5%, equivalent to a capacitive reactance of $31700/f_{mc}$ shunted by a resistance equal to 1/PF, or 200 times this reactance, i.e., $6.3\ 10^6/f_{mc}$. At intermediate frequencies the input may be considered as the low-frequency and high-frequency impedances in parallel. The low frequency resistance may be neglected at all but the lower radio frequencies as the loss factor in the input capacitance will predominate. It is interesting to note that the characteristics of the input capacitance determine the input shunt resistance at high frequencies to such an extent that it is practically impossible to determine by measurement whether the diode is turned on.

The probe time-constant is an important specification where very low audio frequencies or pulses are to be measured. Increasing the time-constant results in an increasingly sluggish response, and if this is done simply by increasing the diode load resistor, grid current trouble from the dc amplifier may be encountered.

The standard probe, with its self-contained large coupling capacitor, responds down to low audio frequencies. It is recommended for use up to 50 mc and, at somewhat reduced accuracy, to over 100 mc. For a probe to be generally useful at frequencies above 50 mc, the resonant frequency should be raised, the transit time reduced and, most important of all, the input capacity should be greatly reduced.

RCA Victor's New Offices

RCA Victor Division's New York and Chicago regional offices have been moved to newer and larger quarters. The New York office, managed by M. F. Blakeslee, is now at 36 W. 49th St. (Radio City), while the Chicago office is located in the American Furniture Mart Bldg., 666 N. Lakeshore Dr., and is managed by H. A. Renholm.

Hallicrafters' New Plant

The Hallicrafters Co., manufacturer of radio equipment, has moved to 4401 West 5th Ave., Chicago 24, the location of its large new plant and extensive laboratories.

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The Webster Electric crystal cartridge is a uniform producer of true tone quality. In addition to faithful reproduction, they are dependable and have long life. Their past record of performance insures their future dependable service.

The Webster Electric cartridge has balanced construction that produces maximum output at designated tracking pressures—with minimum distortion and minimum mechanical reproduction. There are models designed for sharp cut-off at higher frequencies, while others provide response over an exceptionally wide frequency range through use of an extremely lightweight moving mass—a Webster Electric development. Sharp resonance peaks are avoided and efficient performance obtained.

Write Webster Electric Company, Racine, Wisconsin, for full information and complete listing of tone arms and cartridges that are now available.

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NAVIGATION AIDS

(*Continued from page* 75)

In order to search for a desired ground beacon an external manual control is switched into the grids of V_6 and V_7 and the strobes may then be moved back and forth until a signal is picked up.

An indication of the signal is given visually by a neon lamp in the plate of V_{17} which is turned on by the integrated positive pulse from V_{14}, whenever the wide strobe contains a signal.

A rate-measuring unit has been built in a separate box which may be added to the distance indicator unit. Without going into details it may be mentioned that this rate unit is intended to provide ground speed on a meter, with a suggested scale reading from minus 50 through zero to plus 300 miles per hour. The operational accuracy is not yet known, though bench tests indicate the instrumental accuracy is of the order of two or three miles per hour. In the event that the rate meter has a useful application it will be built into the distance indicator unit.

Long Distance Navigation

The conference adopted low frequency Loran for long distance navigation and set up a schedule for the installation of stations all over the world. Almost all the information that has been published on the subject of Loran has referred to the so-called standard Loran which operates in the vicinity of 1.95 mc. Low frequency Loran, on the other hand, operates at 180 kc with a 10 kc bandwidth.

At this frequency, ground wave propagation may be relied upon to a distance of 1500 to 2000 miles. Long pulses, (300 micro-secs.), and large antennas (625 ft.), umbrella loaded, are proposed. The base line used is long. The experimental system set up for test by the U. S. Navy in 1945 consisted of a master at Cape Fear, N. C., with slaves at Brewster, Mass., and Key Largo, Fla. Standard Loran receivers equipped with a converter for the low frequency were used and in fact this is the recommended type of operation.

Television technics are used in

the receiver and indicator circuits. The receiver diagram shows an rf amplifier which is tunable to four frequencies. The IF amplifier bandwidth is 45-60 kc. The gain of the third IF is gated in synchronism with the two parts of the indicator display, so that different degrees of gain may be used for master and slave pulses in order that pulse amplitudes may be matched on the display.

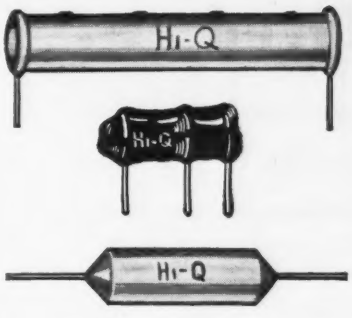
The Indicator block Fig. 13 is quite complex and may be analyzed from the diagram. One of the counter circuits is shown in detail in Fig. 12. The 100 kc crystal, which controls all timing operations is followed by a limiter stage (not shown) in which a triode tube is driven from cut-off to saturation. The resulting voltage is applied at A to a cathode follower buffer stage, T_1 which drives the blocking oscillator counter circuit T_2. The positive bias and the time constant in the grid circuit are so arranged that T_2 fires on every fifth pulse from T_1. The output at the plate consists of sharp negative and positive pulses as shown at B.

Instrument Landing System

The instrument landing system standardized by the convention was the localizer-glide path intersecting beam scheme wherein the pilot keeps his attention fixed on a cross pointer meter and keeps the two needles in the center. This scheme is easily adapted to automatic flight inasmuch as the voltages which actuate the meter needles can also be used to control automatic pilot systems. In fact many complete landings have been made under such automatic control.

The conference did not limit itself to the existing system in which the localizer beam is sent out on a frequency of around 110 mc and the glide path around 333 mc but also recommended the further testing and development of the UHF microwave system proposed by Sperry Gyroscope Co. and operating at 2616 to 2640 mc.

The localizer transmitting equipment provides two radio frequency patterns overlapping so that the equisignal zone produces a straight plane through the equipment. One rf pattern is modulated with 90 cps and the other with 150 cps. In the models used during the last



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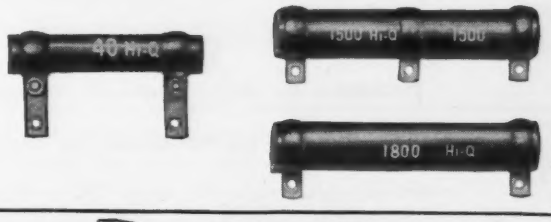
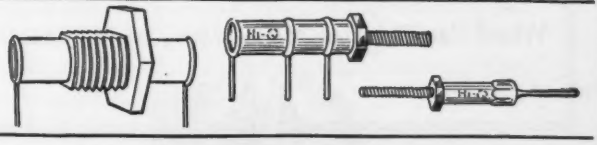
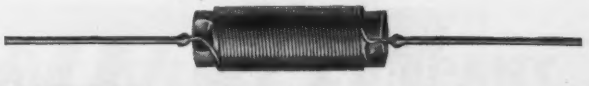


FEED-THRU & STAND-OFF CAPACITORS



CHOKE COILS



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few years the modulation is accomplished with a mechanical variable inductance chopper as illustrated on the accompanying chart. However, later equipment produces modulation by electronic means. Part of the sideband energy is separated from the carrier. The carrier and half side bands are fed to the carrier loop, the major portion of the remaining sidebands being fed to the sideband antennas and a small amount to the auxiliary antennas.

Monitoring of the equipment is provided by the course detector which is located on course 200 feet from the truck and feeds signals back to the indicator box. The course sharpness is 2 db per degree and the clearance between 90 and 150 cycle signals is greater than 6 db at all points more than 5 deg. away from the course.

The glide path transmitting equipment provides an equisignal path at an angle to the ground. The antennas must be mounted at carefully controlled heights above the ground to provide the proper radiation pattern. By adjusting the power ratio between the two antennas and directing the upper antenna 12 deg. from the runway the straight line glide path with a point of contact on the runway can be obtained. The equipment itself is located 400 feet off the runway to one side.

The marker beacon equipment is associated with the system to provide positive identification of the plane's progress along the approach path.

VHF Air Traffic Moved to 122.5 mc

It is expected that by now all airfield traffic control towers will have changed their VHF frequency to the new spot at 122.5 mc allotted for that purpose commencing January 1 of this year. The old frequency was 131.9 mc.

Plastics Convention and Exhibition

The Society of the Plastics industry will hold its annual National Convention at the Stevens Hotel, Chicago, May 6-10. Scheduled to be held concurrently at the Coliseum is the Society's National Plastic Exposition.

PHILCO PROJECTION TV RECEIVER

(*Continued from page 41*)

"One technical issue in this proceeding is the question of how bright a picture is achievable and how an increase in contrast affects the need for brightness. CBS has suggested that with more contrast, less brightness is desirable. Philco has argued that both brightness and contrast are necessary. And with higher brightness, flicker is a problem at the lower frame rate.

"The Philco receiver is an important advance in the art because it provides a substantial increase in usable brightness (of the order of four times) over conventional projection systems and in addition provides substantial protection against room illumination, which means increased contrast. It represents the logical way to obtain both increased brightness and increased contrast."

ACOUSTICAL DESIGN OF BROADCAST STUDIOS

(*Continued from page 55*)

ing for the filtering action of the air in the studio at the high frequencies.

(4) Due to the dispersion of sound from the convex surface, there is a great reduction in interference between the direct and the reflected sound waves.

(5) A relatively smooth sound decay curve is produced and echoes are minimized.

REFERENCES

Acoustical Materials Association, Bulletins VII and VIII.

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Volkman, John E., "Polycylindrical Diffusers in Room Acoustic Design," J. Acous. Soc. Amer. 13 (Jan. 1942).

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SPECIFICATIONS:

- ***Output Level:*** 54 db below 1 volt/dyne/ sq. cm. at high impedance.
- ***Response:*** Substantially flat within ±5db from 30 to 12,000 c.p.s.
- ***Impedance:*** 50 ohms, 200 ohms, 500 ohms, high impedance.
- ***Directivity:*** Semi-directional. Non-directional when tilted full 90°.
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TV DEMONSTRATIONS

(*Continued from page 69*)

four channels, viz. red, green, blue and sound. The receiving antennas were dipoles with reflectors, affording a gain of 10, located at a height of 66 ft.

For the first time the simultaneous system RCA showed studio pickup. This was accomplished by flying spot scanning from a cathode ray tube. The reflected light from the subject's face was collected by a lens, split into the desired three colors by mirrors, and passed on to three photo tubes, responding respectively to variations of red, blue and green light. In this experiment the area that could be scanned naturally was limited. It is imagined that performing in a dark studio is a little trying for the performers. But certainly it is a cool studio. The eyes and the coloring of the girl we saw by television did not appear natural but the experiment was a success.

Impressions of An Observer. The writer was seated at the same distance from the receivers that he was on the preceding day, about 55 ft. He observed the color fidelity was satisfactory, the shades of red were deep and especially pleasing; when producing a black-white picture the whites were really white. The pictures were larger, (15 by 20 in. vs. 7½ by 10 in.). They were about the same brilliancy as the CBS pictures, (8 ft/l). There was no flicker or color breakup even when viewed at a distance of 4 ft. The lights in the room were dim. When they were raised to give an ambient illumination of 2.6 ft/l the pictures were somewhat washed out but still usable. When the receiver controls, including the electrical controls for registration of the three images, were purposely thrown out of adjustment, the time required to readjust was short. A resolution chart was not shown so the actual resolution could not be compared with that demonstrated by CBS. The special NBC-RCA color movie made a good impression on the audience. Suggested improvements would be more power on the sound channel and increased picture brightness. The RCA engineers, once the demonstration started, left the receiver

control knobs alone during the tests. This was a relief after the CBS experience in this regard. The majority of the visitors agreed that all in all it was a very satisfactory demonstration.

Technical Considerations Regarding Transmission. It was proven that when the RCA simultaneous color system is operating, a standard black-white receiver can obtain satisfactory monochrome pictures by using a small converter to change the received uhf signal to the proper hf signal. The receiver is tuned to the green channel which also carries the synchronizing signal. Conversely a color receiver with an adapter can receive monochrome transmissions in black and white. This proves the compatability of this system with the present standards.

In the demonstration a bandwidth of 14.5 mc was utilized. This can be reduced to 12.5 mc by mixing the high frequency components of the three colors, as explained and demonstrated by Dr. Engstrom. There was no noticeable change in picture quality when this was done. For network operation a bandwidth of 4 mc would be assigned to green and red, with 1.5 mc alloted to blue. If necessary the bandwidth for each color could be restricted so that about the same definition can be expected for this system as for the sequential system when transmitted by coaxial cable.

RCA's Simplified Color Receiver. Parts for a low-cost color receiver of the projection type were shown. The receiver will use 35 tubes. The light source consists of three 1½ in. diam. projection tubes, operated at a plate voltage of 15 kv, spaced 90 degrees around an optical system, the projection lens of which is an f2. The picture brightness will be 15 to 20 ft/l.

In reporting the RCA demonstration it should be mentioned that several observers, mostly from CBS, found faults in the pictures such as: non-uniform lighting, poor sound, yellow halation, lack of sharpness, lack of exact color registration, etc. The answer made by RCA to most of these criticisms was that the system now is only experimental. It will take several years to develop it to the commercial stage.

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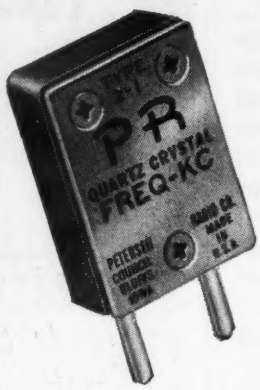

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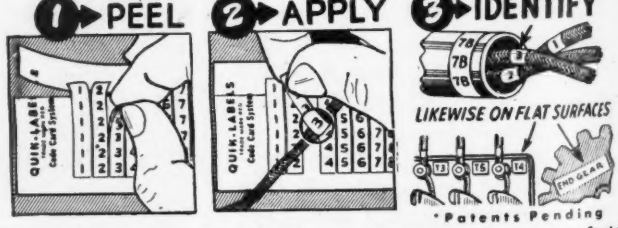

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WIDE READING

(*Continued from page 88*)

where the X's indicate the reactances of the capacitors specified by the indices on the drawing. Variation of X_n, the reactance of the neutralizing capacitor, permits control of power amplification, stability, and amount of feedback, the neutralization then being insured by suitable selection of Z.

Currents through the grid-cathode and plate-grid capacitances produce a positive or negative feedback voltage across the grid reactance, Z. A further negative feedback voltage is generated by the plate current passing the cathode resistance. Stability conditions therefore may not be met, although neutralization is assured. Stability is obtained if C_n is greater than or equal to C_{fp}; the reactance, Z, between the two grids is then inductive.

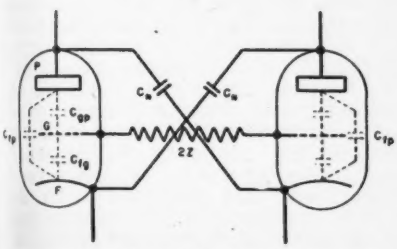

Fig. 1—Neutralization by cross-connected capacitors and reactance between grids

Power amplification will decrease as the neutralizing capacitance, C_n, is increased. If the neutralizing capacitance is less than the plate-filament capacitance, the stage will operate with low excitation power and high power amplification.

Chicagoland Officers

The Chicagoland Chapter of The Representatives at a recent meeting elected the following new officers: President, LeRoy Beier; vice-president, Gordon Gray; treasurer, Bill Ellinger; secretary, R. Edward Stemm.

New Erco Home

Considerably enlarged quarters have been occupied by Erco Radio Laboratories, Inc., in a building especially designed and built by the company for its own use. The new address is Stewart Avenue East, Garden City, New York.

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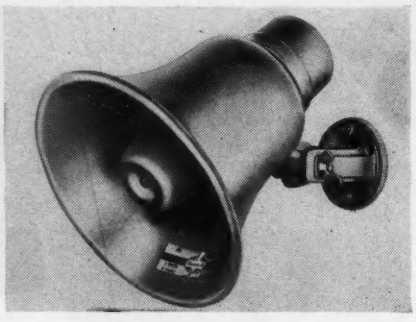
WHAT'S NEW

(*Continued from page* 116)



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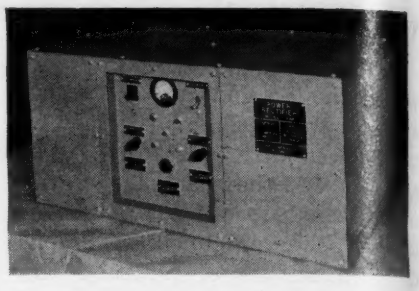
Immunity to moisture, salt-spray, wind and vibration is characteristic of Model MIL industrial paging speaker which is equipped with a reflex air column and built-in PM dynamic driver unit. Model MIL can be used in talk-back circuits and has a continuous power capacity of 5 watts. Frequency response is from 400-9000 cycles with a dispersion angle of 120 degrees. It can be supplied with 8 or 45 ohms voice coils. Weight of the unit is 3½ lb.—*University Loudspeakers, Inc.*, 225 *Varick St., New York* 14.

DUAL BAND FM RECEIVER

(Use Inquiry Card, Mentioning No. 349)

Available with or without power supply and audio amplifier, for rack-mounting or as illustrated, the REL model 646 FM receiver for broadcast stations covers the range from 42-50 mc and 88-108 mc. The 12-tube receiver has a frequency response within ±1 db from 30 to 15,000 cycles with a distortion of less than 1.5% at 10 watts output from 50 to 7500 cycles. For all input signals exceeding 4 microvolts the output signal-to-noise ratio is within 3 db of the optimum obtainable in the band from 50 to 15,000 cycles. IF rejection is better than 65 db and image rejection better than 45 db. Receiver noise is 70 db below full output. Eight and 500 ohm output terminals are provided. Controls include rf gain and tuning, af gain and power, band change switch, tuning and balance meter. The unit operates on 115 volt, 60 cycle, ac and consumes 125 watts.—*Radio Engineering Labs, Inc.*, 35-54 36th *St., Long Island City* 1, *N. Y.*



MARINE POWER RECTIFIERS

(Use Inquiry Card, Mentioning No. 350)

While primarily designed to eliminate running the auxiliary generator when a ship is tied to dock, the marine power rectifiers model A46 and A56 may be used for a wide range of industrial applications. Model A46 operating on the 115 volt, 60 cycle, ac line, consumes 35 amps. at full load and supplies 110 to 150 volts dc at 20 amps. Model A56 also operates off standard ac line, consumes 15 amps. at full load and has an output of 6 to 40 volts dc at 20 amperes. Both models are identical in appearance, have fan-cooled selenium rectifiers, and are provided with dc and ac switches. Output voltage can be adjusted in 50 steps by means of coarse and fine tap switches. The units are equipped with dc and ac fuses and indicating meter.—*Radio Controls Inc.*, 110 *Greenwich St., New York* 6, *N. Y.*

AMATEUR TRANSMITTER

(Use Inquiry Card, Mentioning No. 351)

This amateur transmitter is the first to be developed in which provisions are made to permit all types of emission allowed to amateurs by FCC regulations—CW, AM, FM and ICW. Output is conservatively rated at 100 watts to any type antenna. The tube line-up includes a 6J5 variable frequency oscillator, a 6AC7 class C buffer amplifier or crystal oscillator with provision for two crystals, a 6AC7 reactance tube modulator for FM in any band providing adjustable deviation from zero to 75 kc, four slug-tuned 6L6 doublers or triplers, and a 3D23 tetrode output tube; there is also a 6SN7 for ICW, with variable tone. For AM modulation there is a 6SJ7-6J5 speech stage and two 807 modulators. Power supplies include a 5R4GY for the exciter, a 5R4GY for the modulator and speech amplifier, an 80 for the screens of the modulators, a 6X5GT for bias and a pair of 866A's for the final amplifier. Single dial tuning covers each band (10, 11, 15, 20, 40 and 80 meters), with plug-in coils for the final. The transmitter is supplied with all tubes and coils and sells for $450. — *Supreme Transmitter Corp.*, 280 *Ninth Avenue, New York.*

PORTABLE MARINE RECEIVER

(Use Inquiry Card, Mentioning No. 352)

Model MR-3 two-band marine radio receiver operates on battery power or on ac-dc supply. Having a sliderule dial and a built-in loop antenna, the set can be used on the marine and on the standard broadcast band. The receiver is weather resisting.—*Jefferson-Travis, Inc., 380 Second Ave., New York 10, N. Y.*

CRYSTAL MICROPHONE

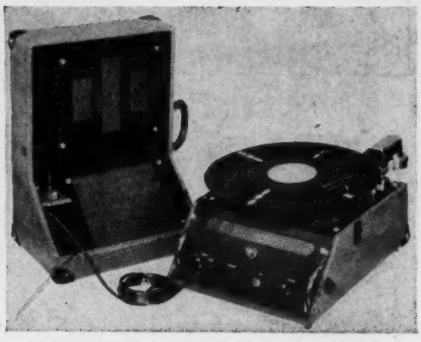
(Use Inquiry Card, Mentioning No. 353)

Recommended for use with public address and paging systems and communication applications Conneaut model 600S crystal microphone has relatively high output and a wide frequency range, smooth up to 10,000 cps. It is equipped with type S on-off switch. The unit has a chrome body and a plastic grille. —*The Astatic Corp., Conneaut, Ohio.*

FM & TV DIPOLES

(Use Inquiry Card, Mentioning No. 354)

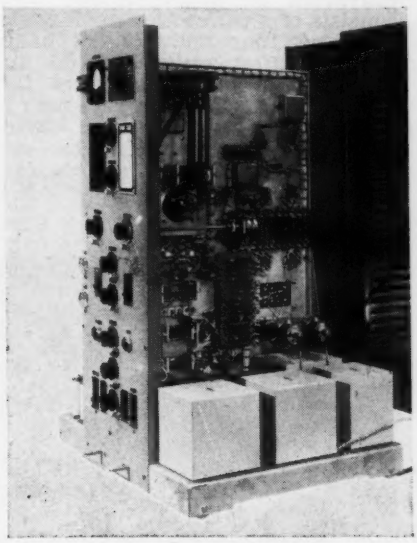
Bakelite and polysterene have replaced the wooden spreaders and mounting members on the new line of Taco dipoles for television and FM. For the downlead, a ribbon transmission line, comprises two stranded conductors insulated by a wide band of polysterene resulting in a loss per 100 ft. of only .02 db at 10 mc, 1.25 at 50 mc, and 2.1 db at 100 mc, with 300 ohm surge impedance. Enamel-finished steel tubing is used for the supporting members.—*Technical Appliance Corp., Flushing, N. Y.*



TRANSCRIPTION TURNTABLE

(Use Inquiry Card, Mentioning No. 355)

This 12 in. transcription turntable wil play 6 to 16 in. records and transcriptions at 33⅓ and 78 rpm. The amplifier supplies four watts undistorted output and is provided with a 3-position fixed tone control and an RCA accordion speaker mounted in the lid. The pickup is mounted on an extension bracket for maintaining proper alignment. Microphone input for PA use may be added.—*United States Recording Co., 1121 Vermont Ave., N.W., Washington 5, D. C.*



VHF TRANSMITTER

(Use Inquiry Card, Mentioning No. 356)

Occupying a minimum of space type TV-50-A vhf transmitter for ground-air communications is housed in a welded steel cabinet and may be serviced from the front while in operation. The transmitter can be supplied for any frequency from 100 to 162 mc and has a power output of 50 watts at 100 to 140 mc and 40 watts at 140 to 160 mc. Power input is 115 volt, 60 cycle, ac. Having a modulation capacity to 95% at 400 cps with less than 10% distortion, the unit has frequency response of 150 to 4000 cps within 3 db of 1000 cycle response. An audio peak limiter limits positive and negative peaks within 1/100 second, so that 12 db increase will not cause overmodulation or more than 5% increase in distortion. The transmitter feeds into a 50 to 75 ohm concentric cable.—*Radio Receptor Co., Inc., 251 W. 19 St., New York 11, N. Y.*

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TWO MODELS OF THE
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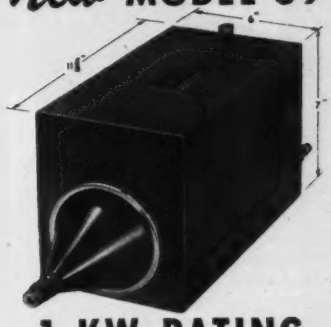
COAXIAL LOAD RESISTOR

New MODEL 69



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(with auxiliary cooling)
300 WATTS
(without cooling)

Both Offer
A CONSTANT RESISTANCE OF 51.5 OHMS
AT FREQUENCIES FROM DC TO OVER 1000 MC

MODEL 81

75 WATTS RATING
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50 WATTS
(without cooling)

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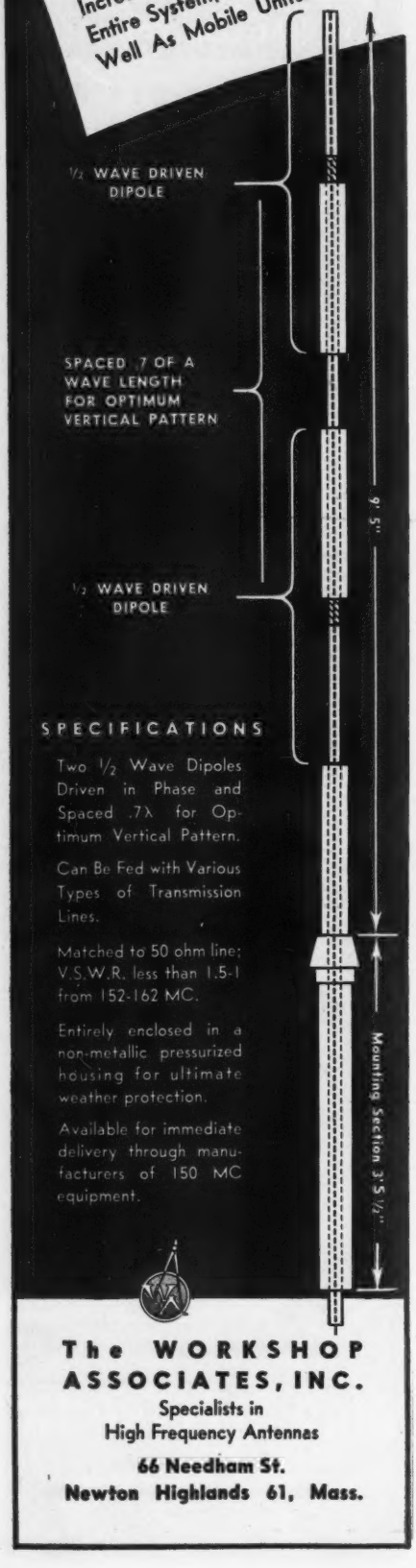

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Can Be Fed with Various Types of Transmission Lines.

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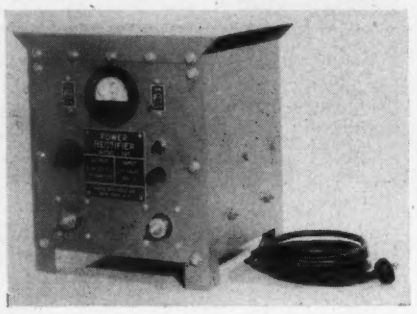


MARINE POWER RECTIFIER

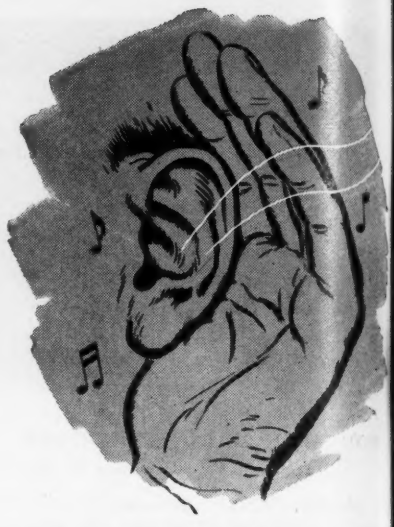
(Use Inquiry Card, Mentioning No. 357)

Operating directly off the dock-line when the ship is tied to dock the marine power rectifier model A-66 can be used for all applications where 6 or 12 v. dc at a maximum of 50 amps. is required to charge batteries. The continuous duty unit, which operates off the 115 volt, 60 cycle, ac supply and consumes 10 amps. at full load, consists of a convection cooled selenium rectifier and control panel. An indicating ammeter, 6-12 volt switch, pilot lamp and input fuse are provided. Charging rate may be adjusted by means of tap switch on the control panel. The unit weighs 60 lb.—*Radio Controls, Inc., 110 Greenwich St., New York 6, N.Y.*

INTERCOM SYSTEM

(Use Inquiry Card, Mentioning No. 358)

Equipped with compact speaker stations as small as an ordinary desk clock this 2-station intercom system has separate amplifiers and speakers, permitting remote location of the amplifier at any out-of-the-way point. Conversation may be carried on at normal voice level using a two-position switch, which returns to the "listen" position, when released. A 3-in. speaker is used. The system connects to any 110-volt, ac or dc outlet. Additional stations up to five can be connected to the amplifier.—*RCA Victor Div., Radio Corp. of America, Camden, N. J.*



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SMALL INTERCOM

(Use Inquiry Card, Mentioning No. 359)

Designed to aid in the training of pilots the Handi-Phone intercom is used in combination with a headset, worn by the student pilot and permits him to receive instructions. The voice is transmitted clearly even under adverse conditions involving high noise level. The compact unit is made of black molded plastic, and is equipped with press-to-talk switch, transmitter, transformer and jack. It is powered with two standard flashlight batteries and weighs only ten oz.—*Wm. J. Murdock Co., Chelea* 50, *Mass.*

CRYSTAL MICROPHONE

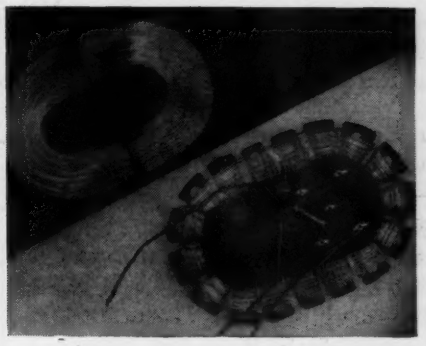
(Use Inquiry Card, Mentioning No. 360)

For commercial sound work, recording, and communications, low-cost model 905 crystal microphone offers an output level of —54 db with a frequency response substantially flat from 50-7,500 cps. The polar pattern is non-directional at low frequencies becoming directional at higher frequencies. The unit is equipped with 8 ft. or 20 ft. of shielded cable.—*Electro-Voice, Inc., Buchanan, Mich.*

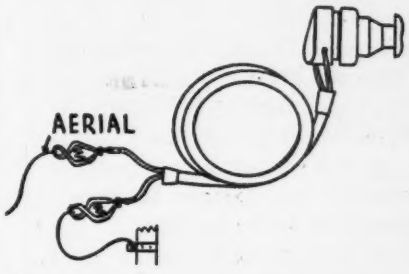
HIGH Q ANTENNA WIRE

(Use Inquiry Card, Mentioning No. 361)

Intended for loop antennas for home radio receivers, the K-1044 small-diameter, polyethylene insulated wire is constructed of bare soft copper No. 24 AWG, the size of the conductor being .0201 in. with overall diameter of .038 in. The "Q" factor of an average size



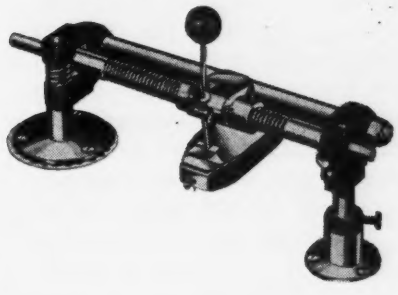
6 x 9 in. loop wound with this wire often exceeds 200 at radio frequencies. Coils without support may be designed. The wire is highly resistant to water, acids, alkalies and oils.—*Federal Telephone and Radio Corp., Newark, N. J.*



MYSTERY RADIO

(Use Inquiry Card, Mentioning No. 362)

Useful as a temporary broadcast station monitor and for signal probing purposes, Mystery radio is a fixed-crystal and tiny ear-plug type device with leads for connection to antenna and ground. It is designed to give good signals within a range of five miles or so of a broadcast station.—*Taybern Equipment Co.,* 120 *Greenwich Street, New York.*



RECORDING MECHANISM

(Use Inquiry Card, Mentioning No. 363)

Techno-Craft recording mechanism is available in a 12 in. and a 16 in. model with a weight of less than 3 lbs. Furnished with either magnetic or crystal type cutting head the cutting pitch of the unit is 110 lines per in. and a novel method of mounting the head produces the correct cutting pressure. The mechanism can be used with any standard recording turntable and is removable from the mounting flange for safe storage.—*Techno-Craft Products Co.,* 200 *Hudson St., New York* 13.

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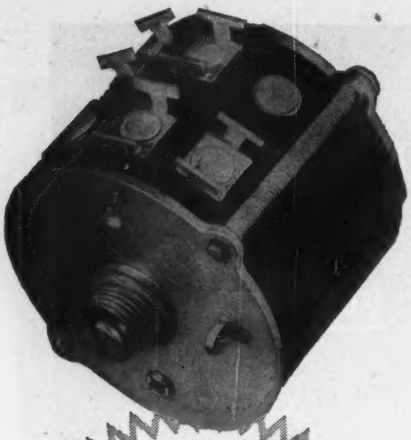

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PERSONNEL

Dr. Homer D. Holler, noted chemist and one of the leading authorities in the field of underground corrosion, has been appointed to the staff of the National Bureau of Standards. Dr. Holler directed pioneering studies in electrochemical and corrosion work in two former tours of duty at the Bureau from 1915 until 1919 and again from 1927 to 1929. From 1929 until rejoining the Bureau's staff he was in charge of corrosion investigation and control with the Westinghouse Electric Corp.

Frederick R. Lack, vice president and director of the Western Electric Co. in charge of the radio division, was elected the new president of the American Standards Association, and **George H. Taber, Jr.,** executive vice president of the Sinclair Refining Co., was elected vice president at the ASA annual meeting. Lack, who has been with Western Electric since 1938, has been a member of the ASA Board of Directors for the last two years and vice-president during 1946. Taber for many years was in charge of all refining operations for Sinclair besides being its former president.

Harold M. Patterson, for the past three years manager of the Taunton (Mass.) works of the General Electric plastics division, has been named engineering manager of the division. He will be succeeded as Taunton works manager by **Frank Gimblette,** who has been mechanical engineer for the plastics division. Patterson, who has been with GE since 1929, will have his headquarters in Pittsfield.

J. J. Mellon, who has been associated with the Allen-Bradley Co., Milwaukee, Wis., for the past two years, has been appointed chief engineer of that company. He previously held engineering and executive positions with Westinghouse Electric Corp., and Clark Controller Co. He will assume the activities formerly directed by Gustav O. Wilms, who will continue to serve on a consulting engineering basis.

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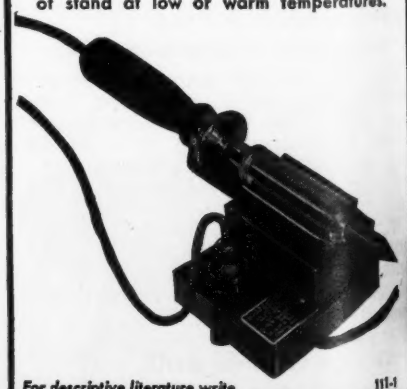

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John H. Miller has been elected vice-president and chief engineer of the Weston Electrical Instrument Corp., Newark, N. J. For twelve years following World War I he was chief engineer of the Jewell Electrical Instrument Co. which was merged with Weston in 1931, at which time he became assistant chief engineer of Weston. In 1937 he took charge of Weston's commercial engineering division which he managed until he was appointed chief engineer in 1944.

J. H. Miller

S. L. Parsons

Stuart L. Parsons has been appointed to the newly created post of chief engineer for the tungsten and chemicals division of Sylvania Electric Products Inc. at Towanda, Pa. He joined the company's physical research department in September, 1939.

Eugene Frekko has been appointed chief engineer of Cornell-Dubilier Electric Corp.'s electrolytic division at South Plainfield, N. J. Frekko has been with the company ten years, succeeding **Paul McKnight Deeley,** vice president, who was formerly chief engineer of the electrolytic division and who since has been promoted to manager.

Preston M. Hall has been made technical executive of the Resistance Welder Manufacturers' Assn. A former president of that organization, he served as chief of the Resistance Welding Section, WPB, from 1942-1945. His headquarters will be the association's office at 505 Arch St., Philadelphia 6.

Dr. Winton I. Patnode, chemist on the staff of the General Electric Research Laboratory at Schenectady, has been placed in charge of the Hanford Branch of the Laboratory at Richland, Wash. He has been with the chemical section of G.E. since 1931.

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NEW BOOKS

Electrical Network Calculations (Tabular Methods of Solution)

By D. E. Richardson, Senior Physicist, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. Published by D. Van Nostrand Co., Inc., New York City, 1946. 270 pages. $5.75

A tabular method to solve a number of simultaneous equations is presented. The method is based on pressing one unknown as a function of the others, substituting the value in the remaining equations and thereby reducing their number by one. This is repeated until the value of one unknown is evaluated, which is used to determine a second unknown, etc.

It appears that the tabular method requires a considerable amount of neatness and correct aligning of a rather large number of coefficients all deprived of the specifying multipliers, the unknown variables, which tends to confuse the computer. Several mistakes as to the sign, and omission of the factor 4 in one of the examples on page 238 obscure the explanations given in the Appendix A. Application of the method to the solution of electrical network problems, which in many instances can be reduced to the solution of simultaneous equations, is set forth in detail and many examples are included.

The Decibel Notation

By V. V. L. Rao. Published 1946. Chemical Publishing Co. Inc., New York, N. Y. $3.75, 180 pages.

The first American edition of this book, originally published in Madras, India, is a literal transcription of this comprehensive work on the application of the decibel notation to radio and acoustics and retains many English terms such as valves, gramo-pickups, etc. This is made somewhat more noticeable by the display of British equipment — of little interest to the American engineer — and the absence of sufficient explanation of decibel units used specifically in American broadcasting systems and industry, such as the VU, etc. Apart from this, the book which explains in detailed, semi-mathematical language

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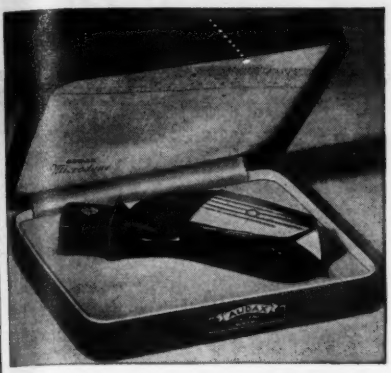

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the origin, development, and a wide range of applications of the decibel, undoubtedly will be of value to students, engineers and technical workers in the radio and acoustics field. Especially of interest to the radio engineer is a section on radio receiver tests and calibration of audio components. Other sections include the application of the db notation in transmission lines, filters, and in acoustics. The book is profusely illustrated with a large number of graphs and tables, and appendices contain tables of natural logarithms and antilogarithms.

Inorganic Chemistry

By W. Norton Jones, Jr., Professor of Chemistry, Colorado State College of Agriculture and Mechanic Arts, Fort Lewis Branch. Published by the Blakiston Co., Philadelphia, Pa., 1947. 817 pages text and 49 pages problems and questions. $4.25

After a few introductory remarks on such subjects as science and philosophy, development of chemistry, scientific laws, theories, divisions of chemistry, matter, measurements, etc., the structure of atoms as related to chemical changes is studied. A detailed account of chemistry, intended for a first-year course in college, follows. An effort is made to present the facts in the light of theory and to refer frequently to the modern concepts of electronic structure and to the periodic relationship of the elements.

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American Telegraph and Telephone Co. is seeking an expansion of radio frequencies suitable for urban mobile telephone service. The company has petitioned FCC asking that the 162-174 mc band, now used by the government for forestry and national park services be allowed for urban mobile work. This block of frequencies, seldom if ever in use anywhere hear metropolitan centers, would provide 200 frequencies, or 100 two-way channels, though even that number is far inadequate in view of expected growth of public services. AT&T estimates that within the next two to five years the 23 different groups of businesses that have expressed need for urban mobile service will require some 8,575 stations. The estimate covers eight of the country's largest cities.

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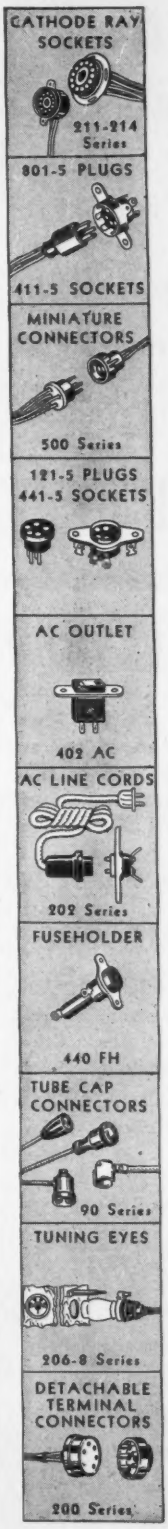

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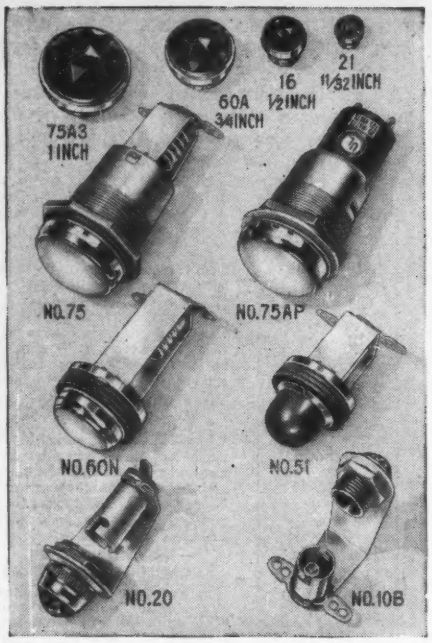

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RTPB INVESTIGATES

(*Continued from page* 63)

with what happens during the retrace time. For instance, pulse width modulation; pulse time modulation (demonstrated by Federal Telephone & Radio Labs.); bursts of frequency modulated subcarrier (tested in the laboratory and in the field by CBS); frequency modulation of main picture carrier. And finally a method that has nothing to do with retrace time, namely, frequency modulation of a continuous subcarrier of the main picture carrier. Beyond doubt there will be other methods proposed. In fact, readers may have superior systems to suggest and it is believed such information will be welcomed by the sub-subcommittee.

Sound Demonstration

The Dome-G.E. system, the CBS system* of bursts and the Federal system were demonstrated to the group investigation method for sound transmission.

After these tests it was evident that in one case the sound signal was lost at locations where the picture signal was still usable and in the case of another system the satisfactory performance of the separate-carrier FM sound transmission could not be duplicated by the diplex method employed. At this time, before other methods could be investigated or further tests arranged, it became necessary for the sub-subcommittee to make an interim decision because the FCC desired a report from RTPB-RMA for the hearing on the CBS petition for commercial standards for color television.

At this hearing, D. B. Smith, RTPB panel chairman, reported for the subcommittee. A portion of the report follows:

"The findings of the Subcommittee to date indicate that multiplexing of the sound on the picture carrier offers interesting theoretical possibilities. However, the Subcommittee generally feels that the short duty cycle methods of sound transmission fundamentally will not perform as well as a separate method of sound transmission. The Subcommittee's position specifies

*Later, on Jan. 27, 1947, CBS announced they were using for sound with their experimental Color television system the separate carrier method with the G.E. Co.-Dome system of reception.

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that a television sound system should perform well, if possible, even when the picture is becoming marginal in quality due to low signal level or presence of interference. Based upon this premise, it tentatively concludes that some method of sound transmission employing one carrier for picture and a separate carrier for the sound will prove more successful than a method of time sharing between sound and picture on a single carrier.

"However, further studies of this problem are scheduled by the subcommittee and actual field tests of several systems employing pulse transmission and separate carrier transmission are still to be carried out."

This interim recommendation in favor of the separate carrier method rather than a diplex method using pulse modulation came as a surprise to some communication engineers who had expected that in the future pulse modulation would supplant other types. To avoid drawing an incorrect conclusion it should be remembered that this is not the case of comparing pulse modulation with other types for use over a simple communication link. It is a special case of transmitting high-quality sound, diplex from a television transmitter. It is believed the sub-subcommittee wisely recommended the system which had been thoroughly field tested by actual use. They selected the method which they were sure would give the television set user satisfactory sound reception.

Mobile Radio System For Use on Farm

Extent to which mobile radio eventually may go is indicated by a grant of the FCC for a large industrial radio system to be used by a farm. Late in December FCC approved the application of the King Farms Co., Morrisville, Pa., to operate a fixed station and eleven mobile units in conjunction with the Bell Telephone Co. of Pennsylvania for office-to-car and car-to-car communication. King Farms operates a 6000-acre truck farm employing up to 600 workers during peak seasons.

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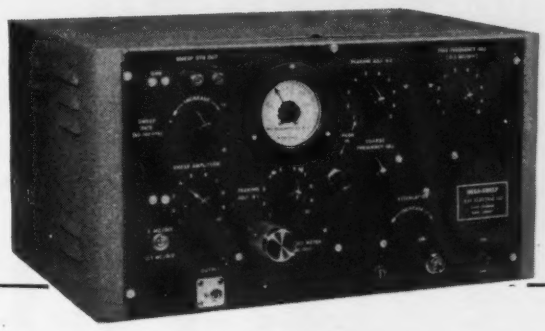

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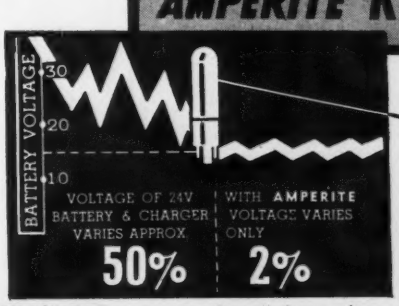

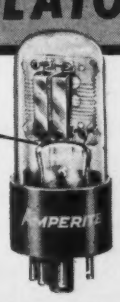

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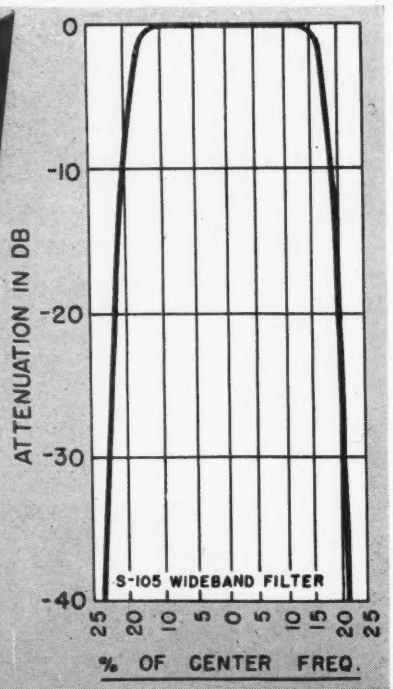

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TV MASTER CONTROL

(*Continued from page 46*)

for an On-The-Air return feed. The remaining four lines are set up on the OAR patch panel to feed whatever positions require this signal, such as client rooms, network outlets, or executive offices.

Returning now to the Preview line amplifier, its two outputs appear on the PVR patch panel where one is reserved as a standby for transmitter feed and the other is sent to the PVR distribution amplifier. The six output lines from this distribution amplifier appearing on the PVR patch panel are divided in a similar manner to that of the On-The-Air signal. One is fed to the Preview desk to be displayed on the console monitor, and another is returned to the selected studio as a Preview return feed. The four remaining lines again are distributed as required.

Network Programs

The above analysis has been predicated on the use of no remote or network programs. Since these are a fertile source of programming material most stations will make extensive use of such program sources. Tracing these signals through the block diagram of Fig. 5, six remote program sources are observed to appear on the RFR patch panel. If the video signal is sufficiently stable as to require no further modification, it may be patched directly to one of the four remote bridging amplifier inputs, appearing as eight output lines on the RFR patch panel. Alternatively, two of the remote program sources may require clamping and sync stretching in which case these are fed through sync stretcher inputs 1 and 2 on the RFR patch panel.

In the sync stretcher units, these signals are both subjected to a line-to-line clamp as well as to a circuit providing for expansion of the sync-to-picture ratio, the outputs appearing also on the RFR patch panel. By means of the latter facility, it is possible for two sync stretchers to service a number of successive remote programs. A maximum of ten signal lines appear as outputs on the RFR patch panel. These are selected as required by the line amplifiers of

both the On-The-Air and Preview rack and are directed to the transmitter network outputs or other points.

By way of summary these operations may be grouped as follows: Of a total of six local studio signals and six remote or network programs, four are selected for immediate use. These may be quickly selected by push-buttons in the line amplifier and the output line sent to the transmitter and other points that require an On-The-Air signal.

The same four selected channels are normally fed to the line amplifier of the Preview rack and are dispatched from this point as Preview return feeds to whatever locations require this signal for cueing purposes, with respect to On-The-Air programs. It is of course possible to re-route other program channels for subsequent operations while one channel is being continually fed to the transmitter. A tremendous array of alternative possibilities exist. For example, the output of the Preview line amplifier may be selected to feed a network with a program other than that going to the local transmitter. However, for such portions as should be carried by the local transmitter this variation may be quickly set up through the use of the switching circuits in the On-The-Air line amplifier.

Switching Circuits

The switching circuits in the line amplifier contain not only provision for manual fading of signal channels, but also the facility for automatic fade and lap dissolve between selected channels. Four rates of automatic fade and lap dissolve are available, extending from instantaneous through fast, medium and slow. This automatic electronic lap dissolve feature has worked out successfully in field use, and has been incorporated in the DuMont portable image orthicon chain.

When switching between local and remote programs, one automatically selects between two synchronizing signal channels, one associated with the remote program itself and the other with the synchronizing generator in Master Control. While it has not been

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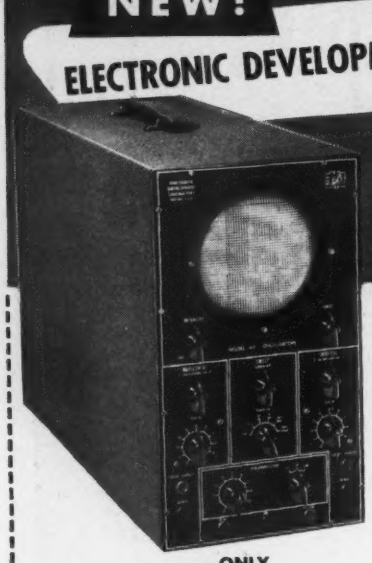

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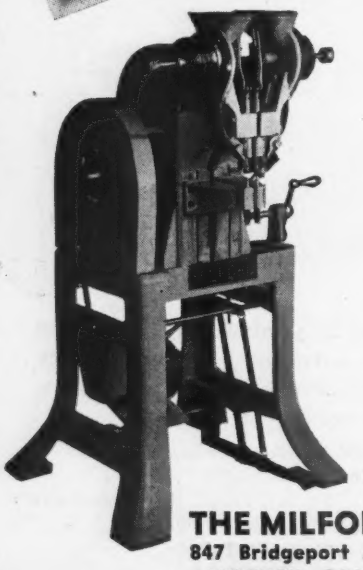

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found necessary to lock the synchronizing channels together at line frequency rate, it is quite important that they be locked together at field frequency rate so as to prevent loss of vertical synchronization at receiver positions in the field.

The specification of the RMA Engineering Department, Subcommittee on Studio Facilities, is such that at the time of switching, synchronizing generators must be phased with respect to one another within 13 lines leading, and 2.5 lines lagging. This synchronization may be obtained in either of two ways. If the remote program emanates from a location within the same power line district as that of a Master Control installation, and if both synchronizing generators are locked with the 60 cycle line, they may differ in phase but will be of the same frequency. If the remote operations crew can receive an Off-The-Air signal from the main transmitter it is a simple matter for them to adjust the phase of the remote synchronizing generator for minimum lag or lead with respect to that of Master Control synchronizing generator. Alternatively the Master Control synchronizing generator may be phased to meet requirements of the remote synchronizing generator.

Synchronizing Problems

However, where the remote program is derived from a location in another power line district, the two synchronizing generators may differ in both phase and frequency of the vertical synchronizing signal. In this case, if vertical synchronizing continuity is to be maintained, it is essential that the synchronizing generator in the Master Control installation be phased with respect to the remote or network program.

To accomplish this objective a sync phasing unit has been incorporated in the remote facilities rack. Its input appears on the RFR patch panel. The output of the sync phasing unit is sent as a 60-cycle line to the Master Control sync generator, and will serve to lock it with respect to the remote network program both in phase and frequency.

As an example of what may be done with a flexible Master Control, let us consider a television station in Washington presenting a program on Inauguration Day 1949. As indicated in the tabulated program in Table II, the station begins its program with news comments from a local studio and then transfers its audience to several spots in succession along the Inaugural Parade route. After the Inauguration ceremony from the Capitol steps a network presents comments on the Inauguration from United Nations dignitaries in New York.

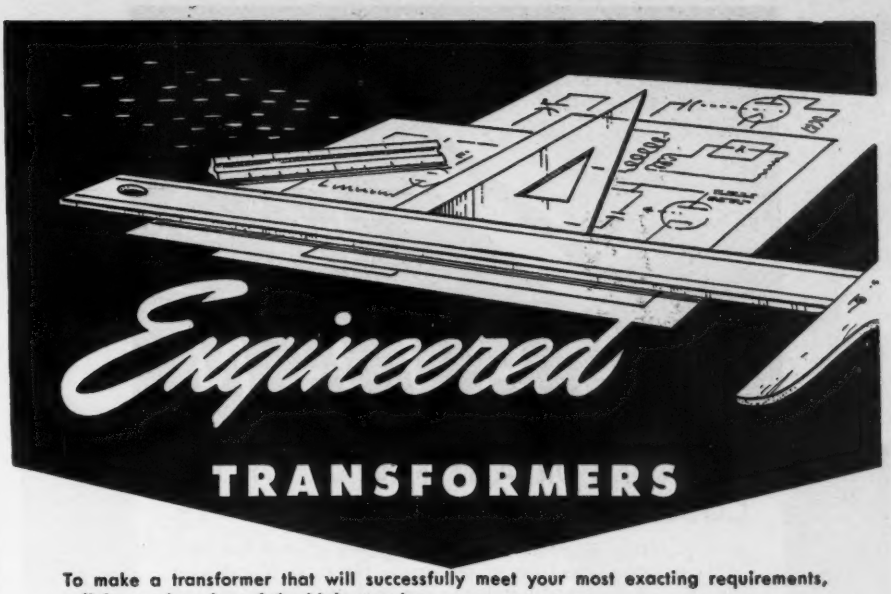
The evening program begins with a film presentation and follows successively with a quiz show, dramatic play, and a song presentation. At the same time the evening programs are taking place, other studios are being used for rehearsals and the results are critically viewed in client rooms and executive show rooms.

Expansion of Station Facilities

In order to accommodate economically the television stations which will begin on a small scale, with a view to later expansion, Master Control packaging is most feasible on an "Add a unit" basis. As indicated in Table I, the simplest type of Master Control for a small station telecasting film and remote programs is that of a single synchronizing generator.

Under the plan exemplified in Table I, when the small television station requires increased program reliability it will usually add another synchronizing generator and a rapid change-over switch. When the small station adds one or more local studios it may expand its available Master Control correspondingly by adding an On-The-Air line channel switching desk as well as picture signal and synchronizing signal distribution racks. (Fig. 4.)

Upon further expansion in the scope and complexity of station programming, Master Control may keep step by the addition of a Preview line channel switching desk as well as preview signal distribution and test monitor racks. The final step in expansion that may be visualized at the present time is that involving programming from a large number of local, remote,



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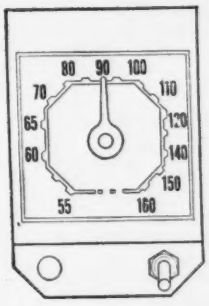

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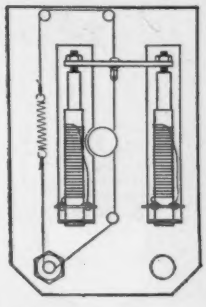

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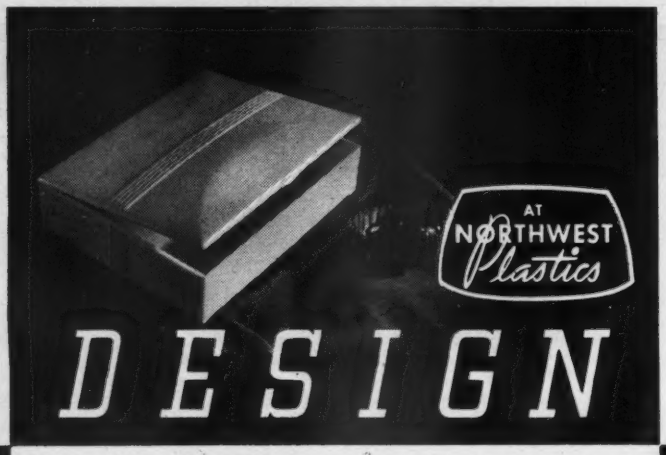

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and network sources. For this, it is necessary only to add a remote facilities rack as shown in Fig. 4.

The programming possibilities in the preceding discussion and the equipment that is required are based on a study of present programming techniques in the large television stations and forecasts of additional needs for the next two or three years. Television is an art which is rapidly growing; for this reason it appears best to limit predictions to this period of time.

Tele-Communications

(*Continued from page* 94)

land as compared with those in the United States. It was brought out in a report to the House of Commons that the British generally keep a receiver in use for a longer period than the average American home and as a consequence British manufacturers must turn out replacement tubes which are obsolete.

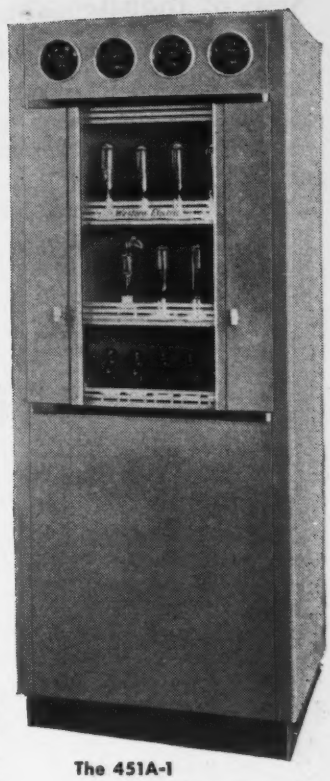
TURKEY PROMISING EXPORT MARKET—Turkey looms as a substantial potential market for home radio receivers under that nation's plan for an extensive electrification expansion. Even though the country's population has only a listening audience of about 1% due to the lack of electrification, the outlook, according to a report just received by the U. S. Commerce Department, is that this listening audience will be increased 150% in the next few years. This report indicated that Turkish receiver market possibilities would be around 150,000 sets per year for the next five years.

It is anticipated that American receivers may take first place in the Turkish market as before the war they were the second only to German sets. RCA, Philco and Spartan were the leading U. S. manufacturers in the Turkish market up to the beginning of the war, but a number of other manufacturers, including Zenith, Crosley, Emerson, Admiral, Westinghouse and Detrola, were in the field. Besides the electrification expansion, Turkey is now building more broadcasting stations, two stations being completed this year. One is being constructed by RCA at Istanbul and the other by Marconi Wireless Telegraph Ltd., Ankara, the latter a short-wave

outlet. The RCA station, when completed, will be the most powerful medium wave station in that part of the world outside of Russia. In addition to home receivers, the Turkish government is showing considerable interest in highway, urban, police and municipal fire radio systems.

MORE POWER FOR FRENCH BROADCASTING—The French broadcasting stations are having their power increased substantially —it will be recalled that the Nazis destroyed 38 of the 42 French broadcasting stations. As of Oct. 1, 1946 there were 42 French stations with a total power of 683.85 kw, operating over 25 frequencies. This amounted to a virtual doubling of the power at the beginning of 1946 for the Parisian chain of 20 stations. The "Chaine Nationale" stations had a total power output of 500.3 kw, Oct. 1. The power of certain stations, such as the Lyon-Tramoyes, Marseille-Realtor 11 and Bordeaux 11 are now being increased. The Ennezat station is being placed in service. With these stations, the total power of the French stations is put at 881.85 kw. To conserve frequency space, certain stations are being synchronized and low power relay stations are being used to cover certain areas of the country.

GREAT BRITAIN RECEIVER EXPORTS AT HIGH LEVEL—Great Britain, which estimated that its exports of radio receivers would be between 100-200,000 for 1946, has greatly exceeded that tentative quota, a recent survey shows. Receivers and receiver chassis, other than combination sets, manufactured exclusively in the British Isles reached 309,911 for the first 11 months of last year and were valued at about £3 million or some 12 million dollars. The figures given for Great Britain do not include re-export of radio parts or complete receivers. That Britain is making great strides in the receiver export field is indicated in a comparison of its 1946 sales with those of 1938, the last year the United Kingdom was engaged in peacetime marketing. In 1938 77,586 completed receivers were exported, which at that time had a value of about 404,000 pounds or $1,600,000.



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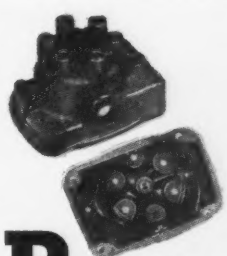

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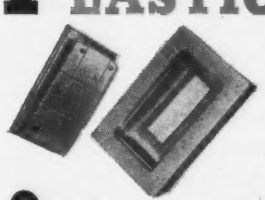

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News of Industry

(*Continued from page 95*)

slow to reach prewar rates, but at the year's end receivers were being manufactured at an annual rate of nearly 20,000,000.

Because some companies did not report their early and unbalanced production of radio sets, RMA tabulations of sets manufactured by member-companies totaled only 13,326,985 in 1946. However, a check with government and other industry reports clearly indicates that total production by the entire industry exceeded 15,000,000 sets.

SETS REPORTED BY RMA MEMBERS	1946
ELECTRIC SETS:	
Table Models:	
*Under $26.95 retail price	2,277,663
Over $26.95 retail price	
AM	6,005,192
AM-FM	13,174
FM (including converters)	2,527
Consoles:	
AM	63,509
AM-FM	40,033
Table Models: Radio-Phono	
AM	1,215,902
AM-FM	22
Consoles: Radio-Phono	
AM	695,250
AM-FM	125,729
BATTERY SETS:	
Portable AC-DC	1,022,689
Table Models	704,711
Consoles	650
AUTO RADIO	1,153,458
TELEVISION RECEIVERS:	
Radio Table Models	5,070
Radio Consoles	
(a) Direct Viewing	1,344
(b) Projection	10
Radio-Phonograph Combinations	52
TOTAL RECEIVING SETS	13,326,985
PHONOGRAPHS:	
Phonographs Only	458,354
Record Players—Radio Attachments	506,362

St. Louis Microphones

St. Louis Microphone Co. has completed its incorporation with an authorized capital of $100,000 and has occupied its new building in the Missouri city for which the company is named. R. H. Mayer is president. The company will specialize in the production of all types of microphones. Plant address is 2726 Brentwood boulevard.

Automatic Electric Expands

Finch Telecommunications, Inc., Passaic, N. J., and Automatic Electric Co., Chicago, manufacturers of tele-communication equipment have entered into an agreement whereby Automatic has acquired rights under Finch patents to manufacture and sell or lease Finch facsimile equipment. Automatic Electric Co., a large supplier of telephone equipment to independent telephone companies, plans to expand its facilities and services to embrace supplementary types of communication.

Lee de Forest Honored

The American Institute of Electrical Engineers has awarded its Edison Medal, established in honor of Thomas A. Edison, to member Dr. Lee de Forest. The citation recognizes his many valuable contributions to the electrical art of communication and was primarily for his creation of the audion vacuum tube upon which rests the entire radio structure.

AIEE Honors Chubb

The John Fritz Medal for notable scientific and industrial achievements during 1946 was presented to Dr. Lewis W. Chubb, director of the Westinghouse Research Laboratories in East Pittsburgh, Pa., at the annual Winter Meeting of the American Institute of Electrical Engineers.

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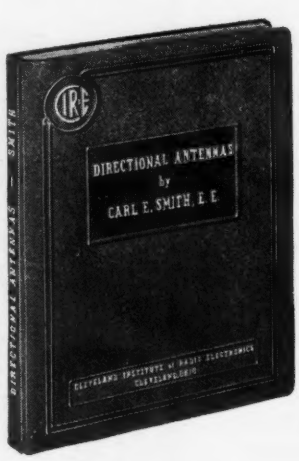

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Midwest Power Conference

The Midwest Power Conference, to be held March 31, April 1 and 2 at the Palmer House, Chicago, is expected to draw an attendance of over 2500 engineers. The conference is being sponsored by Illinois Institute of Technology with the cooperation of Iowa State College, Michigan State College, Northwestern University, Purdue University, State University of Iowa, University of Illinois, University of Michigan, University of Minnesota, and University of Wisconsin. The following societies will participate: Chicago sections of the AIE, AIEE, the American Society of Mechanical Engineers, the Illinois sections of the American Society of Civil Engineers, and the American Society of Heating and Ventilating Engineers, the Western Society of Engineers, and the Engineers Society of Milwaukee. Electronics in industry, to be presented in two sessions led by E. T. Rader, Illinois Tech, and E. B. Kurtz, State University of Iowa, will deal with heating in the wood industry, control, power and process instrumentation.

Parts Show Dinner at Chicago, May 12

The Keynote Dinner of the 1947 Radio Parts and Electronic Equipment Conference and Show will be held in the Grand Ballroom of the Stevens Hotel, Chicago, on Monday, May 12, at 7 p.m. Bill Cunningham, well-known sports writer and commentator, will be principal speaker at this industry-wide meeting of manufacturers and distributors.

According to information received from the show committee, space limitations will permit the acceptance of only the first 1500 requests. Accordingly, reservations are now being accepted by the committee, at $7.50 per plate or $75 per table of ten. Checks should be mailed to the Radio Parts and Electronic Equipment Shows, Inc., Suite 1016, 33 North LaSalle St., Chicago 2, Ill.

Perry Saftler, manufacturers representative, is organizing a special train to be run from New York to Chicago either May 10 or 11. Those desiring reservations should telephone him at REctor 2-5334-5.

Aeronautical Group Plans Expansion

A general strengthening of the Radio Technical Commission for Aeronautics, particularly the employment of a permanent secretariat and an expansion of the RTCA staff, was provided Jan. 28 when the assembly of the organization approved a revised constitution and by-laws at the annual meeting. In addition, under the terms of the new document, the RTCA Executive Committee will meet monthly to keep closer watch on developments in the field and the activities of the RTCA, instead of the former quarterly sessions.

At the meeting, Dr. J. H. Dellinger, of the Bureau of Standards, was unanimously relected as RTCA chairman, and D. W. Rentzel of Aeronautical Radio, Inc., was unanimously reelected as vice chairman. L. M. Sherer continues as executive secretary.

The new constitution is expected to step up RTCA activities considerably because of its provisions for the enlarged technical and clerical

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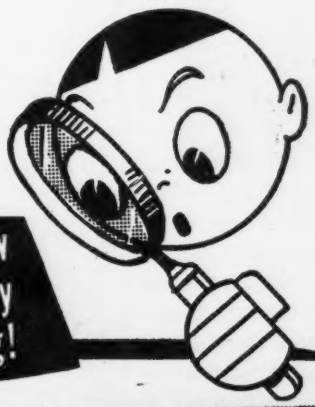

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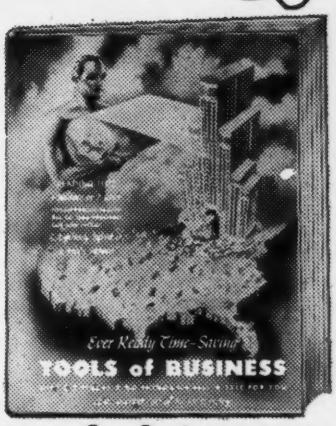

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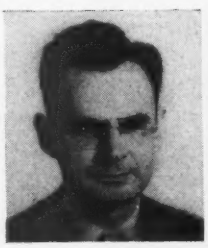
staff and the more frequent meetings of the organization's governing body. It provides also that the Assembly—all members of the RTCA—meet semi-annually in March and September, replacing the former annual meeting. Because of the session this week, however, it is expected that the next Assembly meeting will be in September of this year.

The constitution, which replaced the first RTCA charter adopted in January, 1942, also defines the objectives of the RTCA as "the investigation of all available or potential applications of the telecommunications art, their coordination with allied arts, and the adaptation thereof to recognized operational requirements."

Rose and Pierce Honored by IRE

The Institute of Radio Engineers has awarded the Morris Liebmann Memorial Prize for 1946 to Dr. Albert Rose of RCA Laboratories, Princeton, N. J., and the Liebmann Prize for 1947 to J. R. Pierce, mem-



Dr. Albert Rose

J. R. Pierce

ber of the technical staff of Bell Telephone Laboratories, New York. At the same time, the IRE Awards Committee announced the election of 25 engineers and scientists to Fellowships in the Institute. Formal presentation of the honors were to be made March 5 at the annual banquet of the IRE.

Dr. Rose has concentrated his research in the field of television camera tubes. In 1937 he conceived the idea of the orthicon camera tube, forerunner of the Image Orthicon. It was for his work on the Image Orthicon that Dr. Rose received the 1946 prize.

Pierce has been carrying on research in high frequency tubes and it was for his specific development of the traveling wave type of tube that he received the 1947 Liebmann Memorial Prize.

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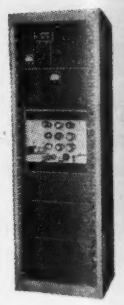

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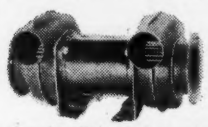

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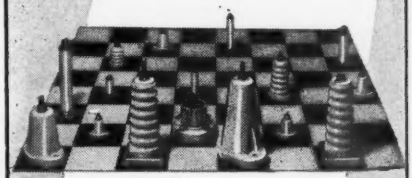

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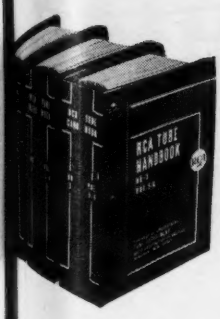

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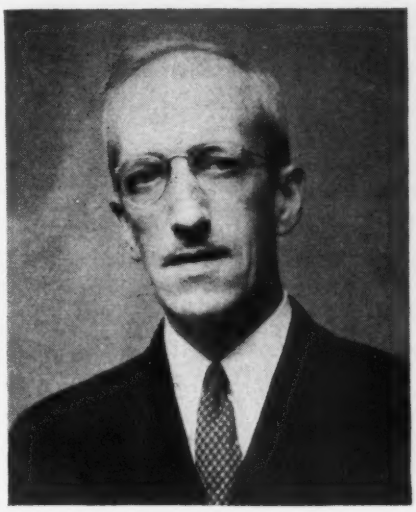
McMinn Appointed T-T Executive Editor

Stanley P. McMinn, for the past four years managing editor of *Electronic Industries,* predecessor of *Tele-Tech,* has been appointed executive editor of the latter publication. He joined the Caldwell-Clements organization in 1942 with an extensive background of pub-

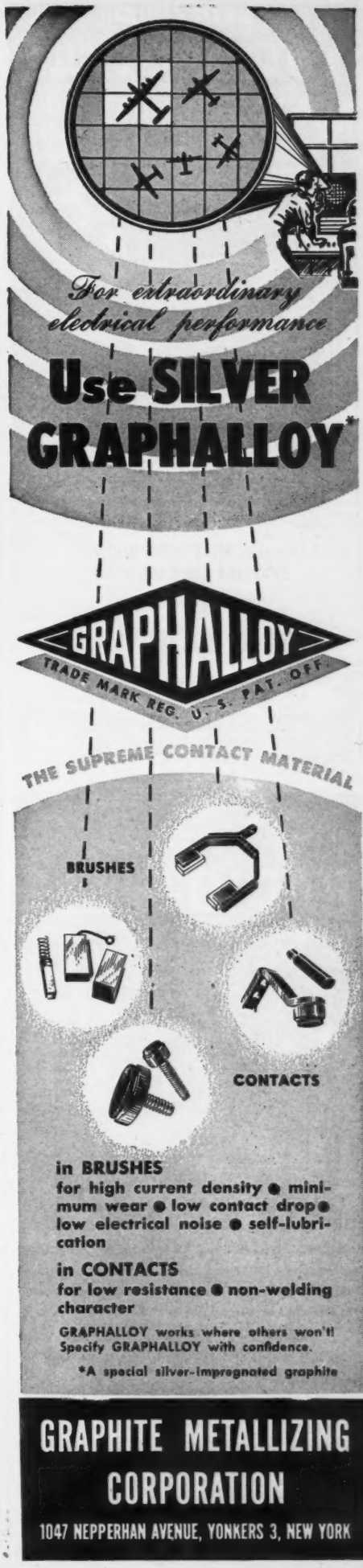


Stanley P. McMinn

lishing experience in a number of fields including automotive engineering, civil engineering, aviation, radio communications and several others not so closely connected with electronic affairs. For more than 20 years he has been a prominent radio amateur (W2WD), has carried on considerable experimental work in the UHF bands, during the last war was drafted by the U. S. Signal Corps to organize and operate a school where some 500 raw GI's were turned out as finished radio operators. He was also in charge of a Navy project involving the equipment of fighter planes with communication equipment and microwave homing devices.

Raytheon Installations

During its first year's operation, Raytheon Mfg. Co.'s Broadcast Equipment Division, Chicago, sold over 120 complete AM and FM radio station installations and now has more than 260 stations on its books. Of the 120 complete stations sold, over 75 are on the air. The division, sole postwar entrant into the broadcast equipment field, announced its first piece of equipment in Jan. 1946, a 250-watt AM unit.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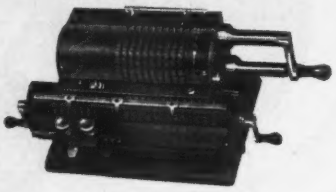

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Ingles Retires

After 37 years of military service, the past four years as chief signal officer of the U. S. Army, Major-General Harry Clyde Ingles retires the end of this month. Beyond a long vacation, his plans for the future have not been made public though it is thought that he may enter the independent telephone field. General Ingles' successor is Brigadier General Spencer B. Akin who will fill the post for the next four years, commencing April 1, with the rank of Major General.

FCC Counts FM Broadcasters Operating

Federal Communications Commission reports that as of the first of the year there were 136 FM broadcasting stations in operation though by the time this note can be printed the total probably will have gone over 200 inasmuch as many stations were practically ready to open at the time the census was completed. Other figures, all dated Dec. 31, 1946, are:

FM Stations on the Air	136
Construction Permits Granted Since October 8, 1945	426
Conditional Grants	211
Engineering approval cannot be given until further engineering data which has been requested from applicant is received	107
Cannot be processed until statement of program plans is received from applicant	9
Referred to Canada for coordination with Canadian FM assignments	6
Awaiting engineering study	81
Awaiting legal study	8
	211
Applications Which Have Been Set for Hearing	118
Heard and awaiting decision	87
Not yet heard	31
	118
Pending Applications	174
Applications which appear complete and are being processed	54
Applications on which a statement of program plans must still be submitted	35
Applications on which transfers of control or assignments of license are pending	6
Applications on which further information other than program plans has been requested by the Commission	15
Applications awaiting outcome of court proceedings	1
Applications which while not themselves in hearing are being held up pending the disposition of a hearing in a related case (either AM or FM)	23
Applications which are being studied in regard to overlap of service areas	27
Applications recently received on which no action has been taken	13
	174

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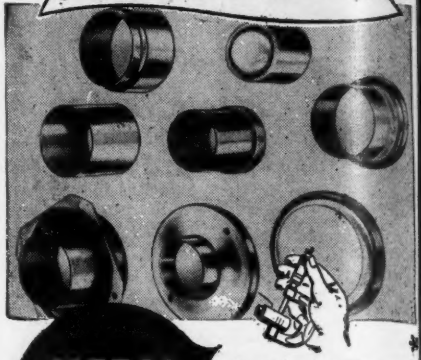

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New Bulletins

TUBE MANUAL

Tube Div. of General Electric Co.'s Electronics Dept., Schenectady, N. Y., has issued a 156-page receiving tube brochure covering all recommended types of the GE and Ken-Rad receiving tube line. Tube types are listed in numerical order by sections, including typical circuits, complete ratings, characteristic curves and associated technical data. The characteristic curves are shown on closely spaced coordinate paper, making them suitable for plotting purposes.

PAPER CAPACITORS

The small, self-healing metallized paper capacitors, recently brought out by Solar Mfg. Corp., 285 Madison Ave., New York 17, are described in detail in a 4-pg. bulletin. Electrical ratings, available designs and engineering applications are given, as well as a table of available SL tubular capacitors.

AC, DC RELAYS

A large variety of relays for every industrial and communications application are described in the 38-pg. catalog published by Advance Electric & Relay Co., 1260 West 2nd St., Los Angeles, Cal. The profusely illustrated brochure includes dc relays, midget relays, hermetically sealed relays, a variety of industrial relays, keying relays, overload relays, time delay units, ac relays, telephone and transmitter relays, and a number of special types. Dimensional sketches, electrical and mechanical characteristics, switch combinations, and other data are given for each type.

TECHNICAL CERAMICS

Representative samples of extruded and machined parts made of Lavite Steatite ceramics for application in communications and industrial electronics are shown in a 16-pg. illustrated pamphlet available from D. M. Steward Mfg. Co., Chattanooga, Tenn. Lavite steatite ceramics are widely used for electrical insulation because of their excellent dielectric properties, heat resistant qualities, and ability to be easily machined. The back of the bulletin contains detailed technical specifications.

BATTERY PLUGS

Up-to-date listings of all types of plugs to fit batteries used in portable radios, testing equipment and electronic devices are contained in a 4-pg. circular issued by J. F. D. Mfg. Co., 4109-4123 Ft. Hamilton Parkway, Brooklyn 19, N. Y. Sketches and descriptions of each type and reference layout sheets are included.

(*Continued on page* 156)

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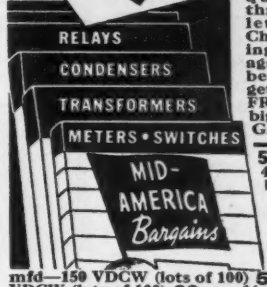

Here's proof of the BIG BARGAINS in radio parts and electronic equipment MID-AMERICA offers EVERY MONTH to qualified quantity buyers through special bulletins and flyers. Check the outstanding buys listed here against what you've been paying—then get MID-AMERICA'S FREE CATALOG and big MONTHLY BARGAIN BULLETINS!

5" Dynamic Speaker, 450 ohm field, hum buckingcoil, double shielded 50L6 transformer (lots of 20) $2.95 ea.
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DPDT ROTARY RADIO-PHONO or BAND SWITCH, ¼" shank 1⅛" shaft (lots of 100) 38c ea.
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ASTATIC HIGH FIDELITY PHONO PICKUP with Astatic L-72-A xtal (lots of 25) . . . . $1.95 ea.
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- BUILT BY WESTERN ELECTRIC:
- 115V., 50-60 CYCLE INPUT:
- EXCELLENT REGULATION FROM 90-130V. INPUT & FROM NO-LOAD TO FULL-LOAD RATING:

MODEL 3

Voltage range: 210-320VDC. Max. load rating: 0.400 Amp. Tube Complement: 2-836; 6-6L6; 2-6SF5; 1-VR105; 1-VR150.

MODEL 8

Voltage range: 590-950VDC. Max. load rating: 0.225 Amp. Tube Complement: 2-836; 2-6L6; 2-6SF5; 1-VR105; 1-VR150.

Both models are supplied in attractive modern black wrinkle finish cabinet. The front panel is a standard 19" relay rack panel 10½" high. Separate filament & plate circuit controls are provided on the front panel along with the voltage control.

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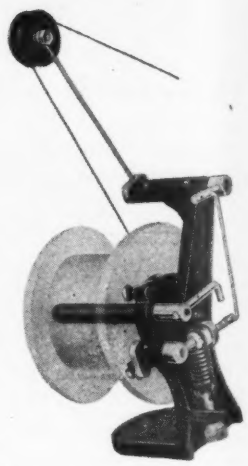

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.25 mf 600 vdc	.25	1 mf 1500 vdc	1.20
.85 mf 600 vdc	.30	.4 mf 1500 vdc	.20
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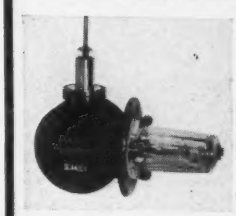
2 mf 4000v 23F47 pyr	5.95

WAVE GUIDE PARTS



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OUR PRICE ... $25.00
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OUR PRICE ... $20.00

Magnets for either Magnetron 12.00
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30 mc oscillator-amplifier with 2 6AC7's. Uses 723ab, Waveguide input, xtal detector.
With 6AC7's 10.00
With 6AC7's, 723ab and 1N21..... 16.50
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A. 90° bend in wave guide 15" long ..... $ 4.00
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SECTIONS

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K. Choke flanges for 3 cm, fits item H, 1" x ½"—2 for 1.49

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SPDT contacts; 5a coil rated 115v/60c 1.39
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Telephone WH 4-7658

(*Continued from page* 153)

INSULATING VARNISHES

A 40-pg. reference booklet containing technical and application data on GE insulating varnishes has been issued by the insulating materials division, Chemical Dept., General Electric Co., Pittsfield, Mass. The data includes specifications, electrical and film properties, cure and aging, chemical properties and baking and air-drying cycles of each type. Thirty-six grades are described for eleven basic varnishes. An excellent reference chart in front of the loose-leaf booklet summarizes the important properties of each type of varnish.

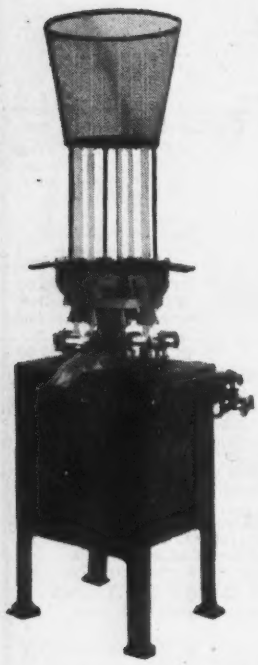
RECEIVING TUBES

Characteristics and socket connections of an extensive line of receiving tubes including projection and direct-view kinescopes are contained in a 16-pg. booklet on "Receiving Tubes for Television, FM, and Standard Broadcast" (Form 1275-C) available from Commercial Engineering, Tube Dept., Radio Corp. of America, Harrison, N. J. All types are listed in numerical-alphabetical sequence of type designations. Information on discontinued types has been included. An additional chart classifying RCA receiving tubes according to function and cathode voltages aids in selection of tubes.

ELECTRONIC COMPONENTS

Intended for manufacturer, distributor, and exporter, catalog M, issued by Eldico of New York, Inc., 44-31 Douglaston Pkwy., Douglaston, N. Y., contains diverse electronic components and equipment of standard manufacture. In 28 pages listings are given of a variety of transformers, capacitors, rf chokes, reactors, coils, switches, insulators, tubes, knobs, meters, relays, resistors, headsets and mikes, terminal strips and miscellaneous parts. A section on microwave equipment includes synchroscopes, frequency meters, signal generators, magnetrons, uhf crystals, tubes, antennas, coaxial cables and fittings.

BAACH-INTERNATIONAL



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Automatic throughout.

Can be synchronized with automatic Stem machine.

Cuts off and flares in one operation.

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Range of *Machine:*

Glass tubing	29 to 45 gauge
Length of flares	5 mm to 80 mm
Forms flares up to	47 mm diameter
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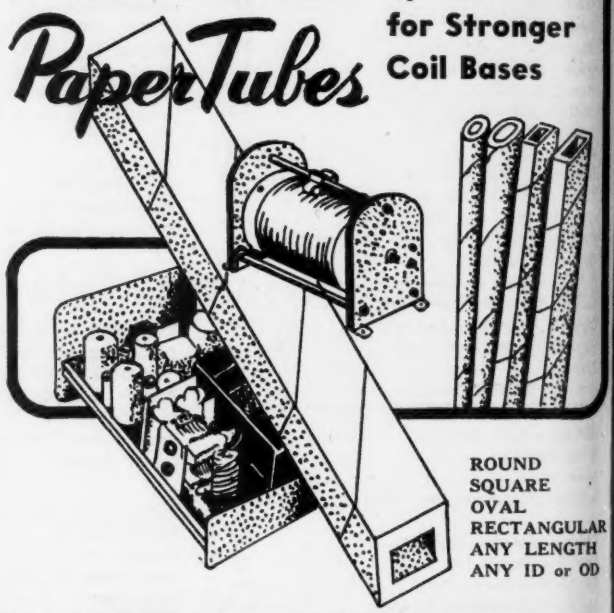
PRECISION *Paper Tubes*

Spiral Wound for Stronger Coil Bases



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SQUARE
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RECTANGULAR
ANY LENGTH
ANY ID or OD

Start coils RIGHT with a good base—PRECISION Paper Tubes. Insure insulation, moisture resistance, heat dissipation. Save space, save weight. Dielectric Kraft, Fish Paper, Cellulose acetate, or combinations.

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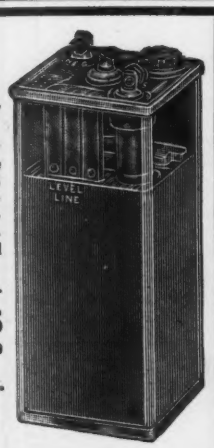
2057 W. CHARLESTON STREET CHICAGO 47, ILLINOIS

WILLARD 2 VOLT
COMPACT RECHARGEABLE
Spill-Proof STORAGE BATTERY



In an attractive Clear Plastic Case. Only 2⅝" square and 6" overall height. About the size of the ordinary 6 Dry Cell. Rating 24 AH. Gangs nicely for other voltages in multiples of 2 volts. Ideal for many applications.

Shipped dry with electrolyte for each in separate container. (Cannot be shipped Parcel Post.)

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BURSTEIN-APPLEBEE CO.
1012-14 McGee
Kansas City 6, Mo.

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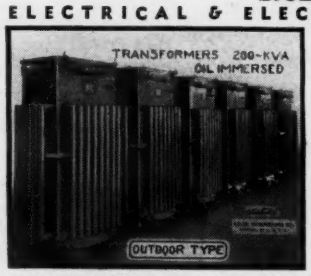
ELECTRICAL & ELECTRONIC EQUIPMENT



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Sizes from ¼ to 250 KVA
For furnaces, lighting, distribution, power, auto, phase changing, welding—air, oil, and water cooled, and special jobs.

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Complete equipment for the manufacture of incandescent lamps, radio & electronic tubes.

SPOT WELDERS Sizes from ¼ to 250 KVA
We have a complete line of spot, butt, gun and arc welders.
EISLER ENGINEERING CO., 778 So. 13th St., Newark 3, N. J.

Air Navigation and Landing–Approved Electronic Systems

At the November 1946 Montreal conference of the delegates to the Provisional International Civil Aviation Organization (PICAO) headed by Edward P. Warner, Council President, a number of electronic aids to air navigation were adopted and operational requirements were set up for the future. Technical information is presented here about these adopted aids. Delegates agreed to try to have their respective governments ratify and implement these choices.

Compiled by H. Gregory Shea for TELE-TECH

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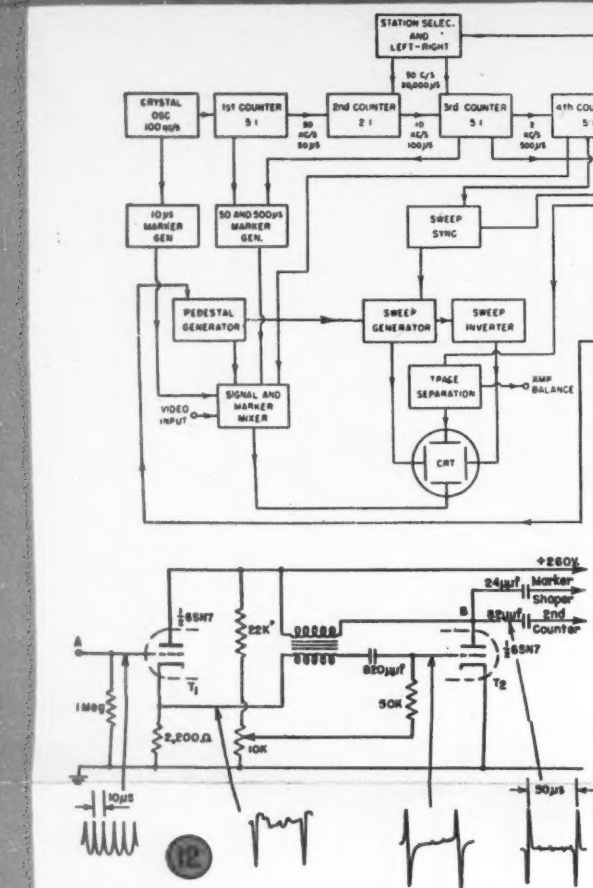
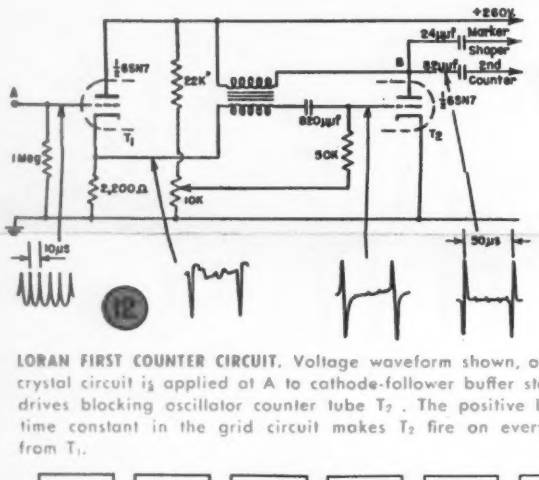
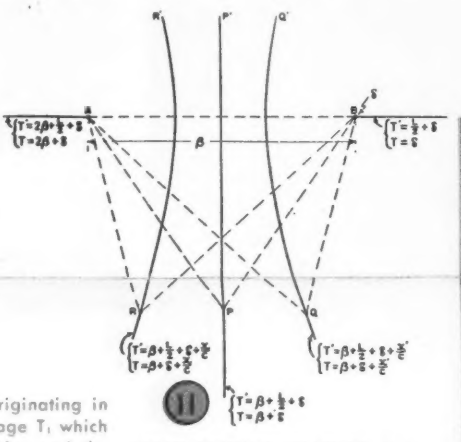
FLIGHT CONTROLS



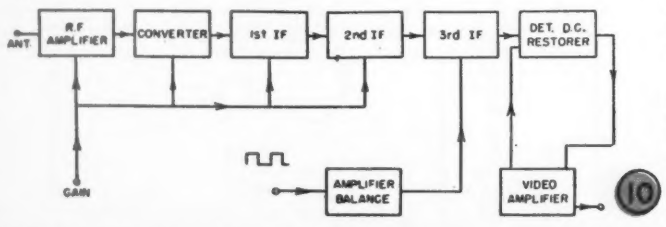
STANDARD LORAN INDICATOR. All timing operations controlled by 100kc crystal variable 35c by two trimmers. Six counters follow for frequency division. Time difference is measured by bringing pulses on upper (A) and lower (B) traces into alignment, then counting markers.



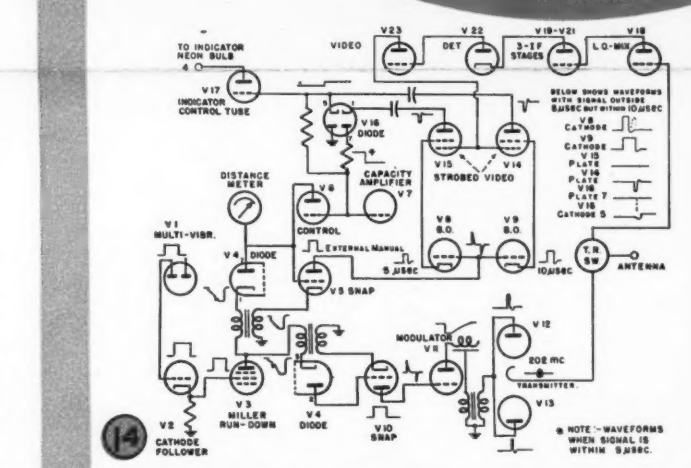
LORAN FIRST COUNTER CIRCUIT. Voltage waveform shown, originating in crystal circuit is applied at A to cathode-follower buffer stage T_1 which drives blocking oscillator counter tube T_2. The positive bias and the time constant in the grid circuit makes T_2 fire on every fifth pulse from T_1.



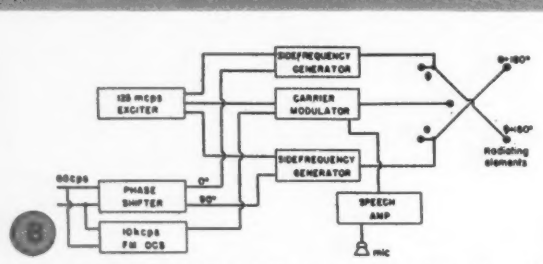
LORAN POSITION RELATIONS. T is indicated time difference, T' true difference, L recurrence interval, D absolute delay, δ coding delay, β master to slave pulse travel time c .1862 miles per micro-second.



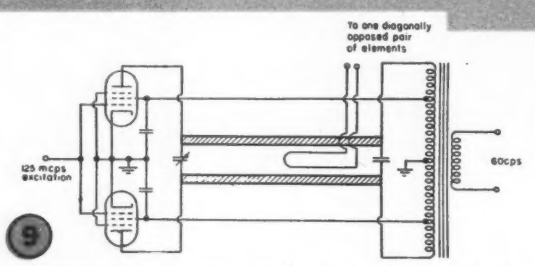
LORAN RECEIVER embodying a simple super-heterodyne circuit. Third IF gain is gated in synchronism with two parts of indicator display to permit matching master and slave amplitudes.



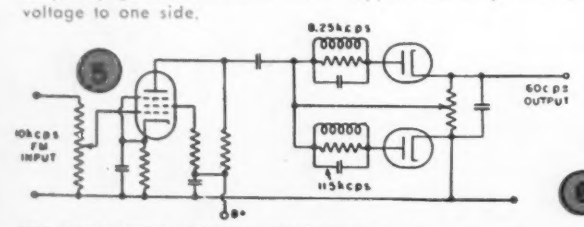
DISTANCE MEASURING EQUIPMENT operating about 200mc. Airborne set timing element is Miller run-down circuit V_3. Driven from V_1, it in turn drives two snap circuits V_{10} and V_5. Current meter in V_6 plate circuit is calibrated in distance.



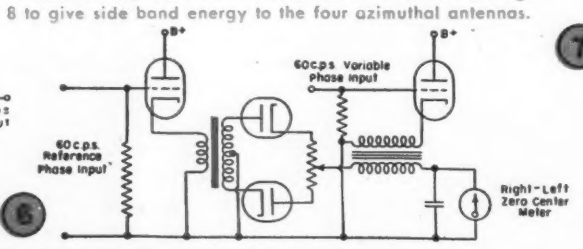
VHF OMNI-DIRECTIONAL RANGE circuit using electronic side frequency generators. Phase shifter supplies out of phase voltage to one side.



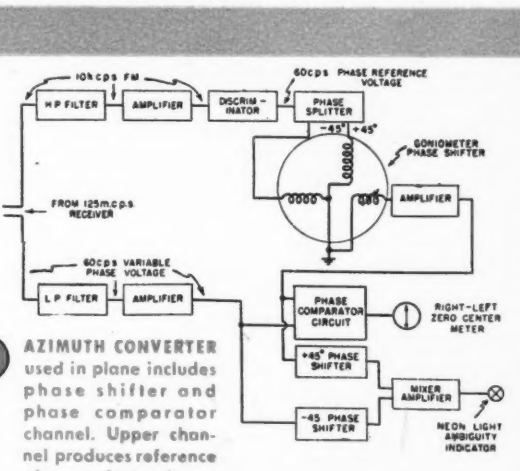
ELECTRONIC SIDE FREQUENCY GENERATOR used in circuit of Fig. 8 to give side band energy to the four azimuthal antennas.



VHF OMNI-RANGE RECEIVER DISCRIMINATOR. The FM 10kc sub-carrier is applied to this circuit which recovers 60-cycle reference phase.



PHASE COMPARATOR used in VHF Omni-range. Indicates zero current when voltages are 90 deg. out of phase. An ambiguity circuit is needed.



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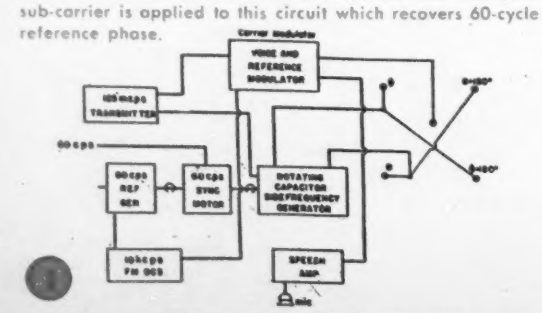
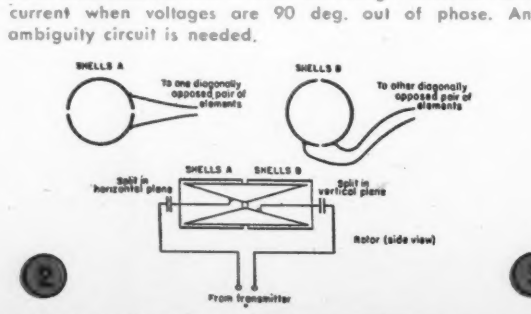
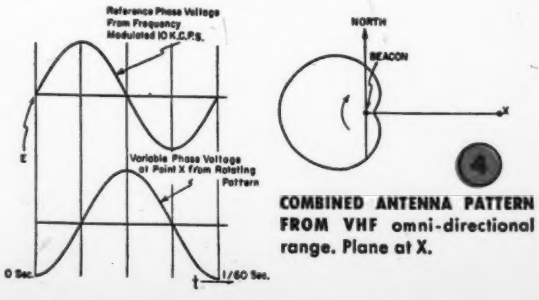


VHF OMNI-DIRECTIONAL RANGE TRANSMITTER with rotating capacitor side frequency generator. Includes voice on reference phase signal.



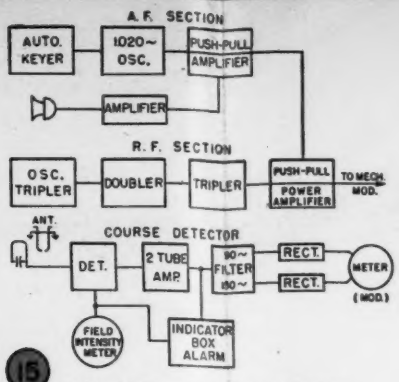
ROTATING CAPACITOR SIDE FREQUENCY GENERATOR. One system of modulating 125 mc carrier to produce only side band energy.



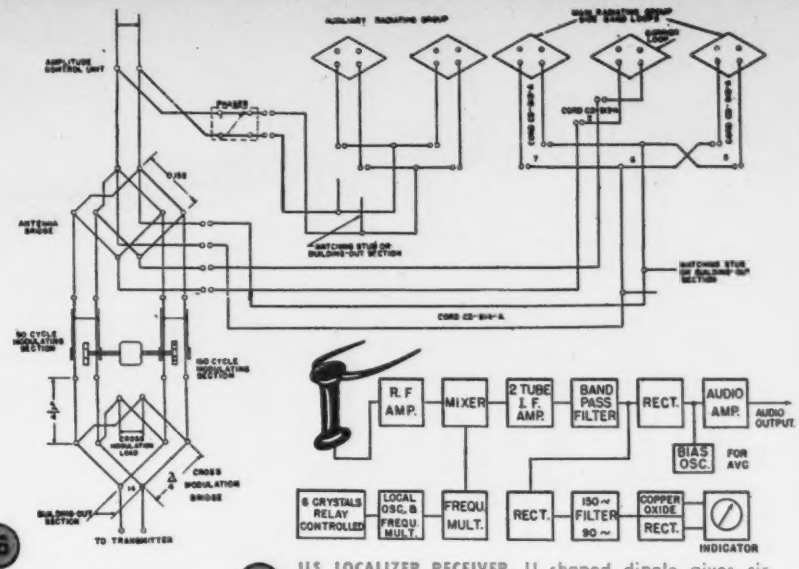
VHF OMNI-DIRECTIONAL RANGE PHASE RELATIONS. Phase of energy field from corner antennas may be compared with center antenna phase.

COMBINED ANTENNA PATTERN FROM VHF omni-directional range. Plane at X.

LANDING CONTROLS



15 **ILS LOCALIZER TRANSMITTER** utilizes standard circuits for RF energy which are modulated by voice or auto keyer and supply antennas of Fig. 16. Monitor circuit is also included. This is required by CAA



16 **ILS LOCALIZER TRANSMITTER** Layout of mechanical modulator and antennas producing intersecting-plane signals respectively modulated at 90 and 150 cycles. The use of the antenna bridge permits transmission with a single array

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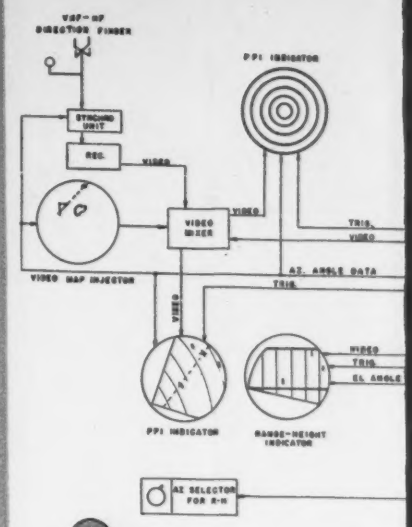
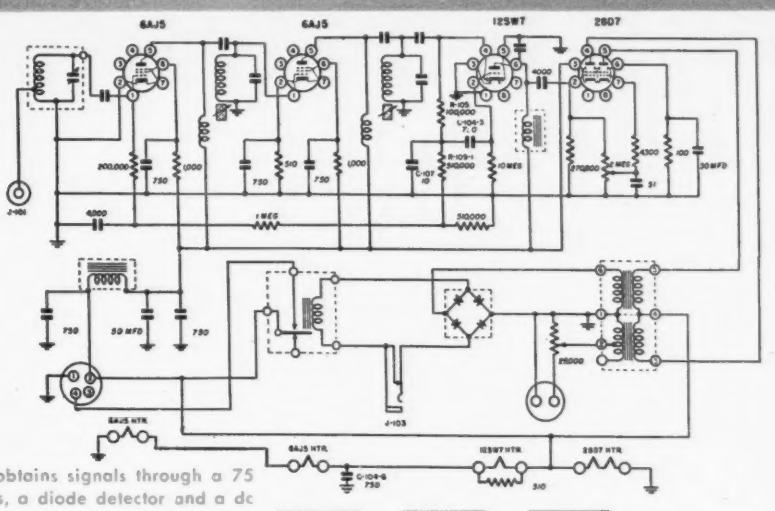
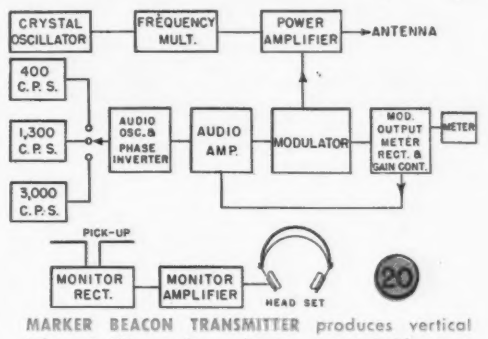


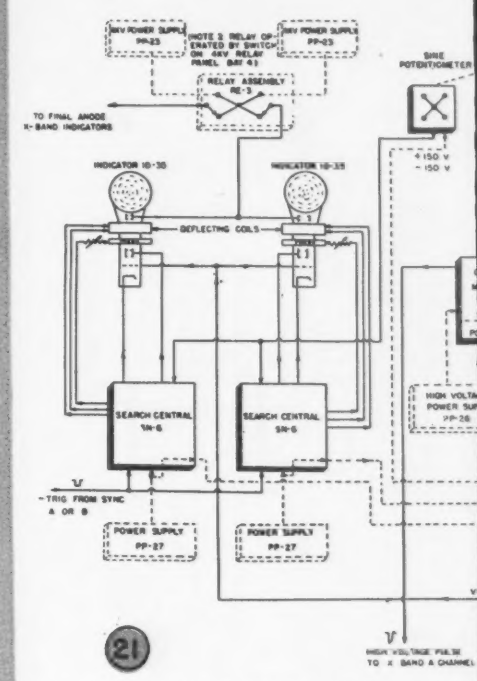
18 **GROUND SURVEILLANCE RADAR.** Useful for and 3 cm height finding radar, video map unit. Operates as ordinary radar in loca is included permitting writing into PPI m



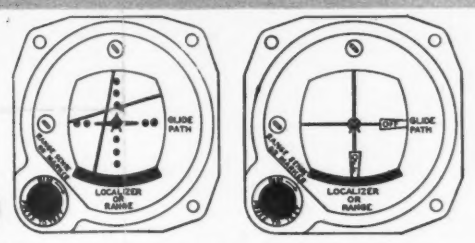
19 **MARKER BEACON RECEIVER** obtains signals through a 75 mc dipole; has 2 RF stages, a diode detector and a dc amplifier operating a light on instrument panel through a relay. Uses 28 volts on plates.



20 **MARKER BEACON TRANSMITTER** produces vertical lobe at 75 mc from dipole mounted ¼ wave above ground. Three oscillators and a motor driven keyer give dots, dashes and "A". Monitor is on antenna mast.



21 **GCA SEARCH RADAR** presents a radar map on within 30 miles and below 4,000 ft. Provides they are turned over to precision system for search beam is 7 deg. wide. Communications used simultaneously. Frequency is 10 cm. Uses modulator. Latter contains common driver st switch tubes, one for search and one for pr array of 33 dipoles mounted on section of 10 c



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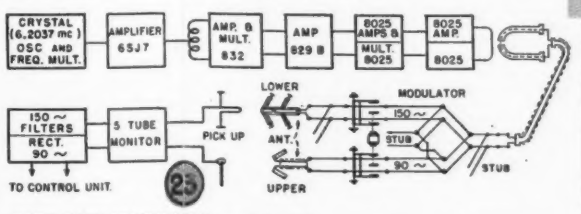

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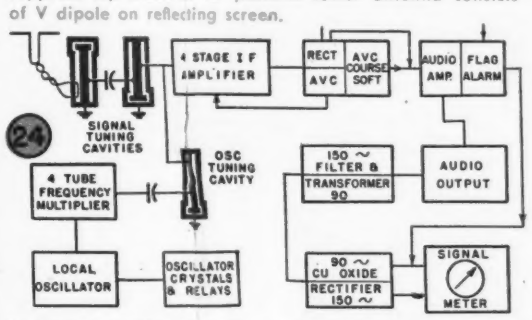

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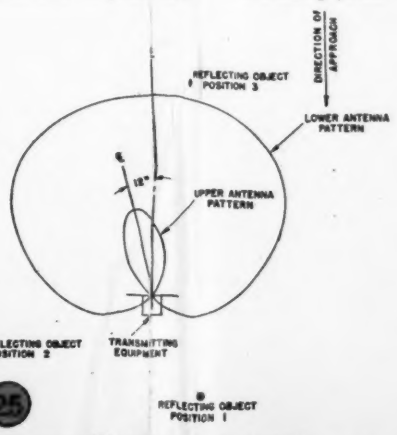
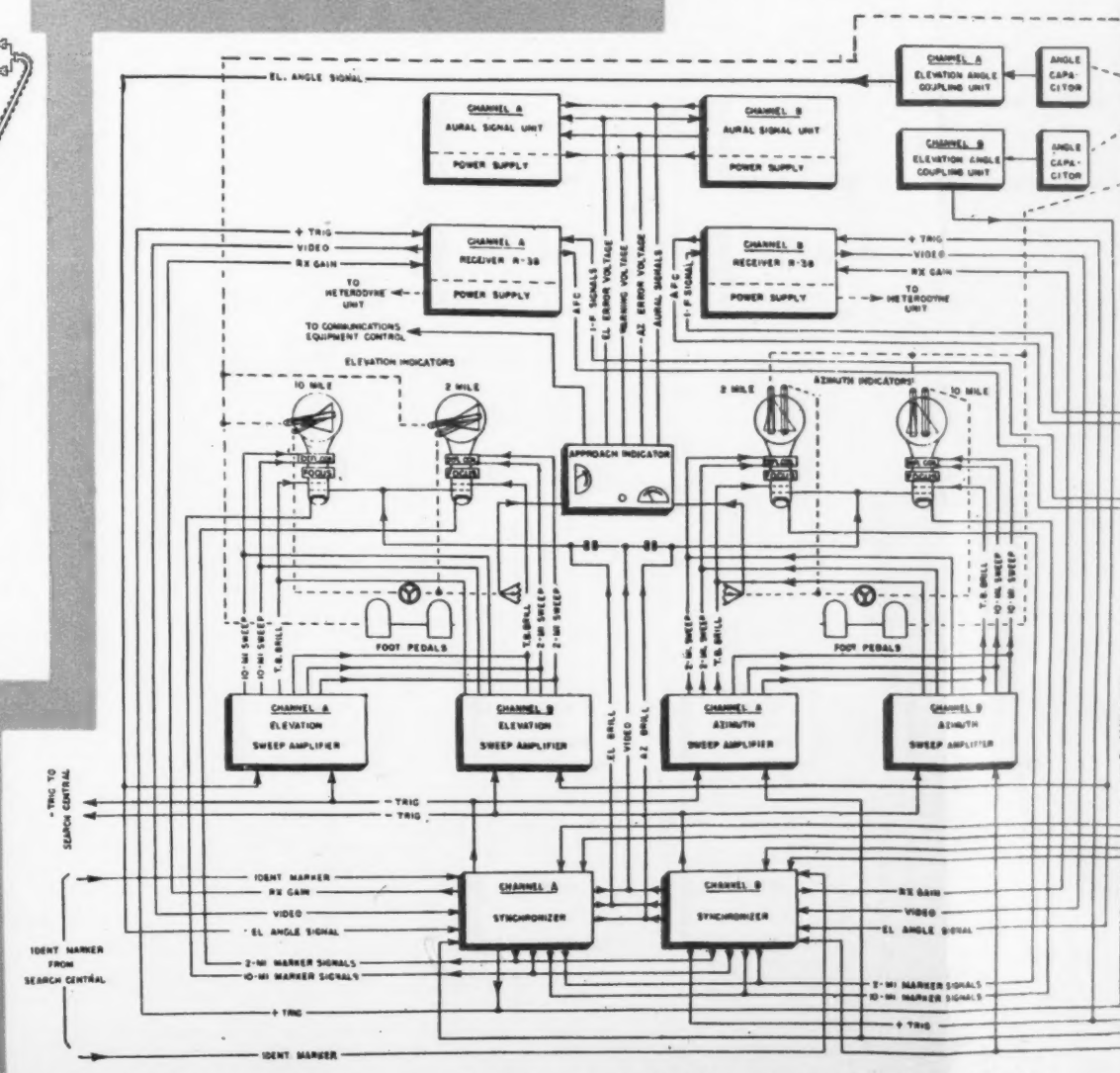


25 **GLIDE PATH HORIZONTAL FIELD PATTERN** showing the top antenna radiation directed 12 deg. off center through the other lobe. This gives straight path on runway.

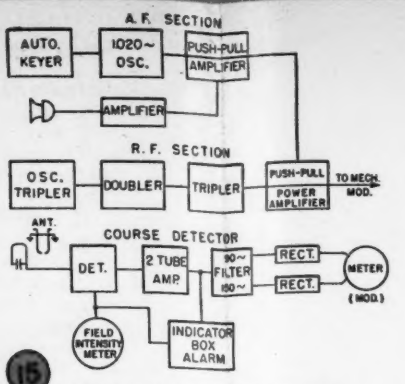


26 **GCA RADAR PRECISION SYSTEM** operates in the 3 cm band and provides elevation and azimuth indications on separate scopes. Output of magnetron is applied alternately to azimuth and elevation antennas by motor driven RF switch. A commutator on same shaft causes echoes to appear alternately on azimuth and elevation indicators. Uses single receiver. Both azimuth and elevation antennas scan electrically by mechanical variation of waveguide width. Elevation antenna uses 173 collinear dipoles to get .4 deg. beam, and scans through 7 deg. Azimuth antenna has 121 dipoles, .6 deg. beam and 20 deg. scan.

...ation and Landing–Electronic Systems

...nference of the delegates to the Provisional International ... headed by Edward P. Warner, Council President, a ...igation were adopted and operational require- ...echnical information is presented here about ...d to try to have their respective govern- ...hoices.

...regory Shea for TELE-TECH
..., Inc., 480 Lexington Ave., New York, N. Y.



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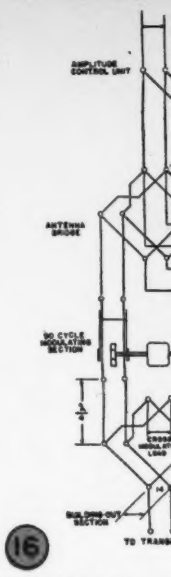

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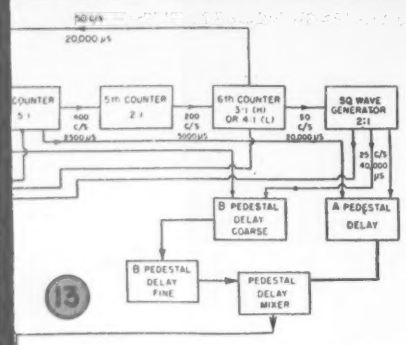
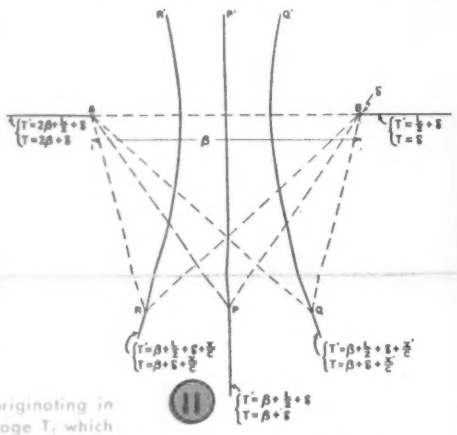


13 **STANDARD LORAN INDICATOR.** All timing operations controlled by 100kc crystal variable 35c by two trimmers. Six counters follow for frequency division. Time difference is measured by bringing pulses on upper (A) and lower (B) traces into alignment, then counting markers.



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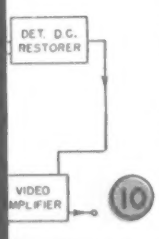

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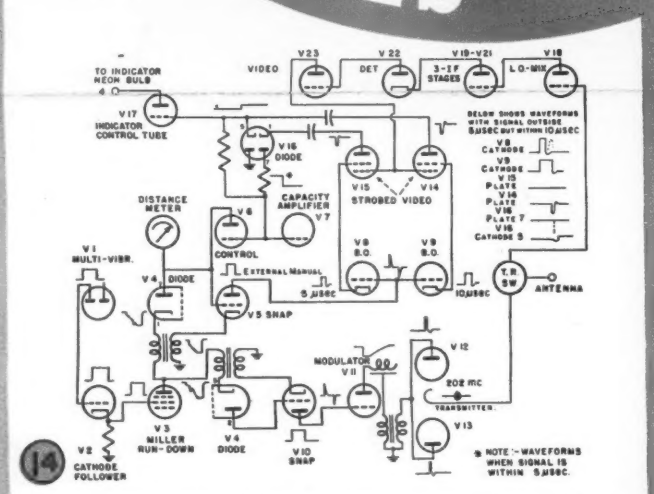

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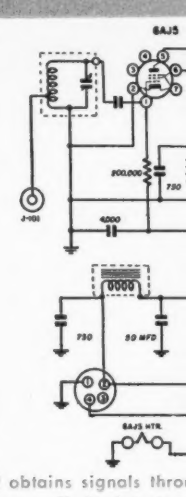

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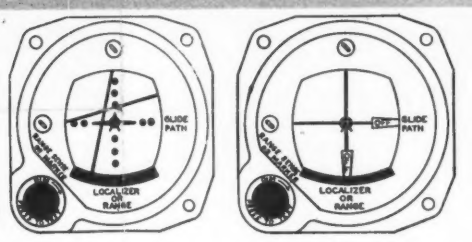

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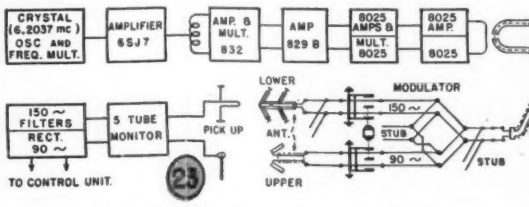

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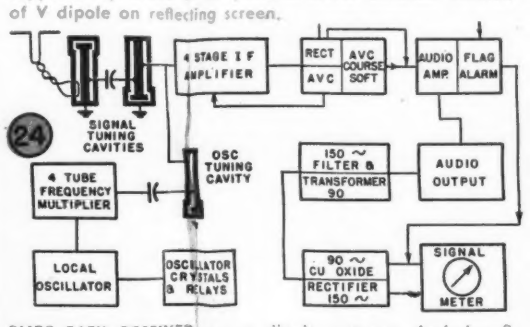

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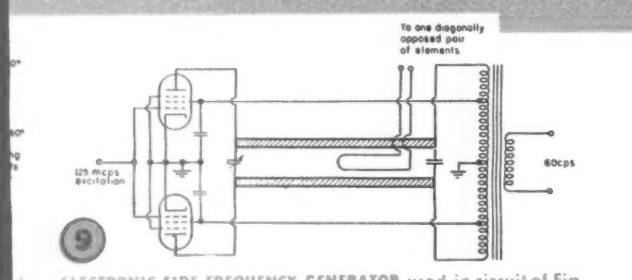

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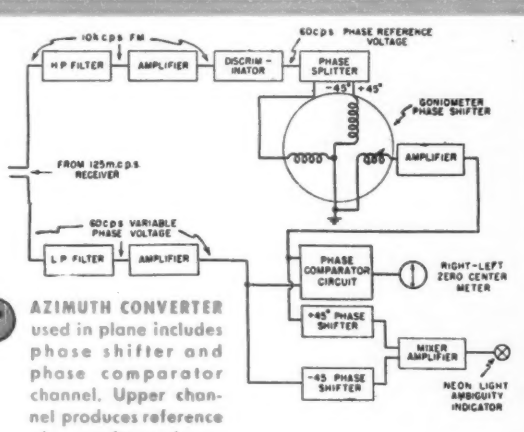

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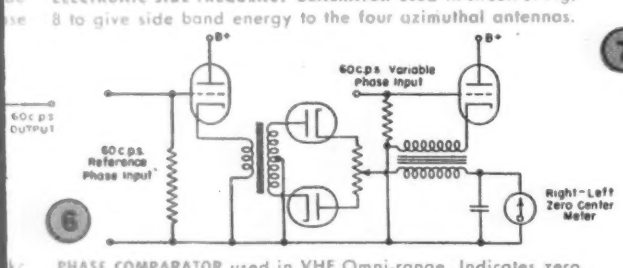

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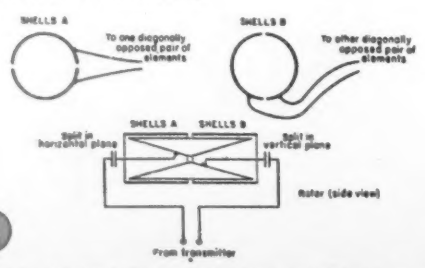

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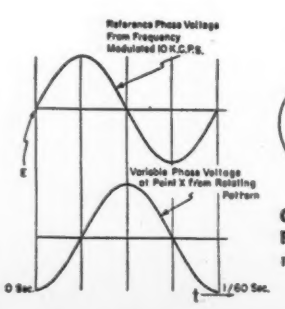

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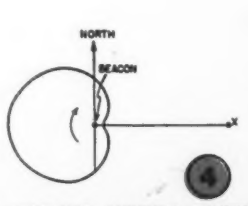

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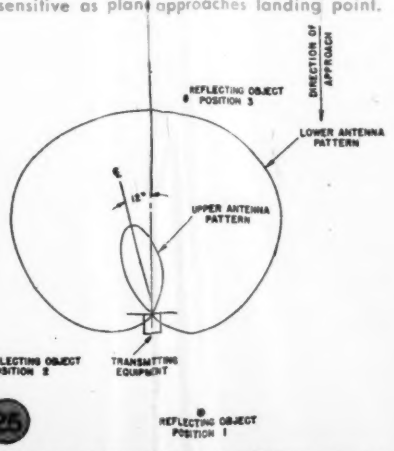

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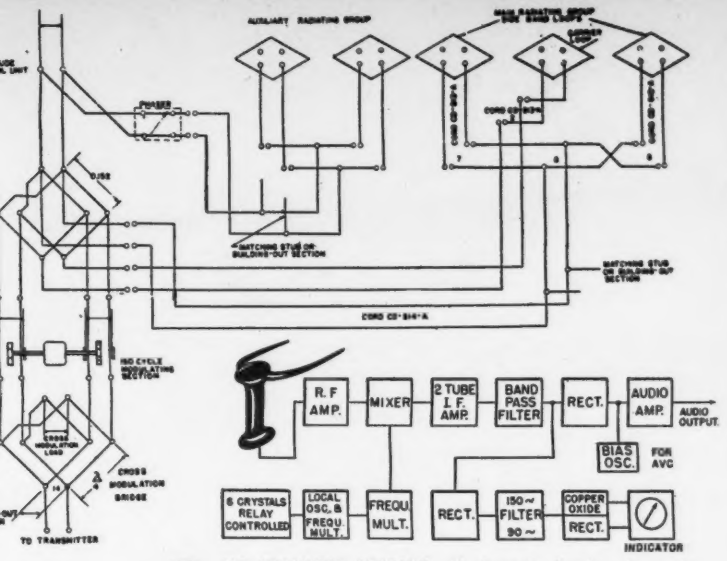

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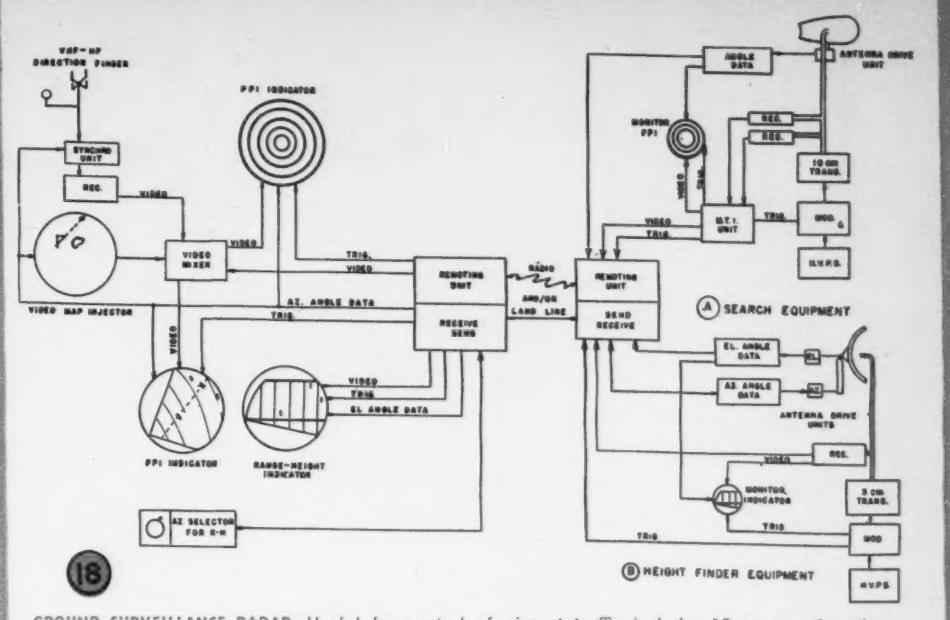
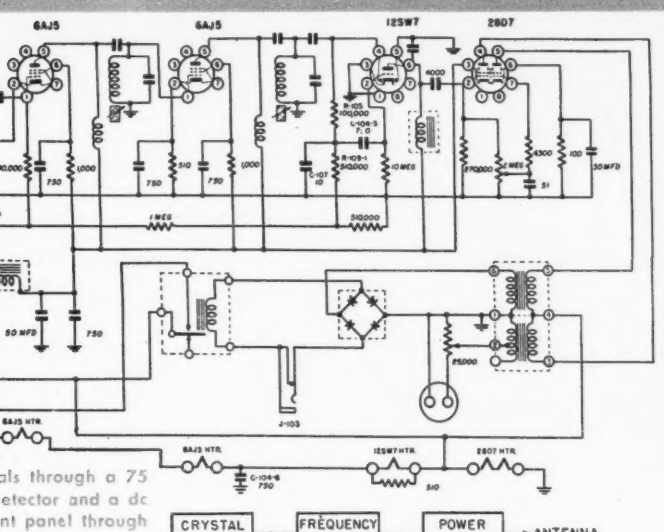
a single array

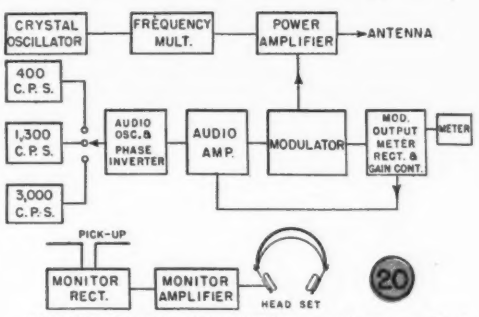
17 **ILS LOCALIZER RECEIVER.** U shaped dipole gives circular pattern. Circuit is 6 channel crystal controlled superheterodyne. Operator needs only switch, frequency selector and volume control. In the AVC circuit bias is obtained from local oscillator and diode section of second detector is used as switch to increase control voltage considerably above normal.



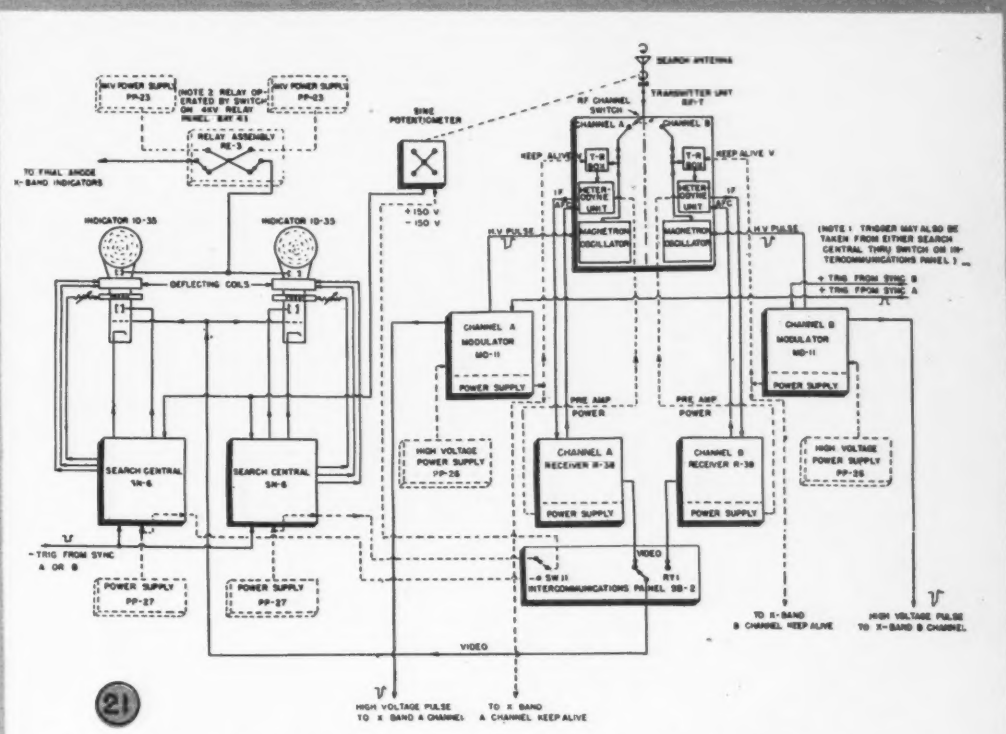
18 **GROUND SURVEILLANCE RADAR.** Useful for control of airport traffic includes 10 cm search radar and 3 cm height finding radar, video mapping unit, direction finding equipment and relay radar unit. Operates as ordinary radar in locating aircraft within 30 miles. Video mapping system is included permitting writing into PPI maps showing runways, obstructions. *(NOT SPECIFICALLY APPROVED)*



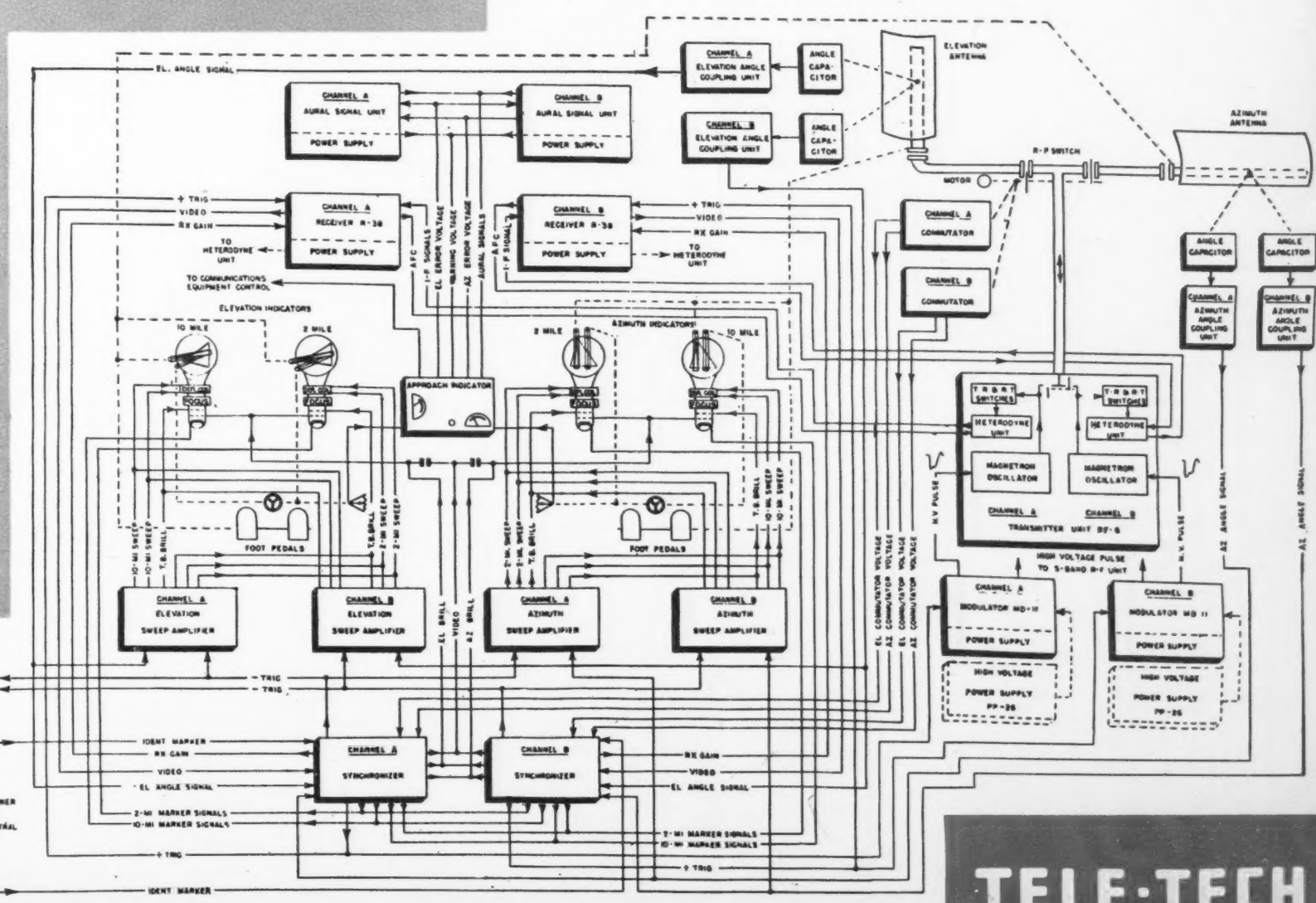
als through a 75
etector and a dc
nt panel through



20 **MARKER BEACON TRANSMITTER** produces vertical lobe at 75 mc from dipole mounted ¼ wave above ground. Three oscillators and a motor driven keyer give dots, dashes and "A". Monitor is an antenna mast.


SEARCH ANTENNA
TRANSMITTER UNIT BF-T
RF CHANNEL SWITCH
SYNC POTENTIOMETER
MAGNETRON OSCILLATOR
DEFLECTING COILS
CHANNEL A MODULATOR MD-11
CHANNEL B MODULATOR MD-11
SEARCH CENTRAL SM-6
CHANNEL A RECEIVER R-38
CHANNEL B RECEIVER R-38
HIGH VOLTAGE POWER SUPPLY PP-28
POWER SUPPLY PP-27
INTERCOMMUNICATIONS PANEL SB-2
HIGH VOLTAGE PULSE TO X BAND A CHANNEL
TO X BAND A CHANNEL KEEP ALIVE
TO X-BAND B CHANNEL KEEP ALIVE
HIGH VOLTAGE PULSE TO X-BAND B CHANNEL

21 **GCA SEARCH RADAR** presents a radar map on the PPI 'scope showing the positions of aircraft within 30 miles and below 4,000 ft. Provides information used in "stacking up" planes before they are turned over to precision system for landing (Fig. 26). Pulse is .5 micro-second and search beam is 7 deg. wide. Communications equipment has 21 channels, 3 of which may be used simultaneously. Frequency is 10 cm. Uses magnetron driven by high voltage pulses from modulator. Latter contains common driver stage triggered by sync pulse and two pairs of switch tubes, one for search and one for precision set. Output of former fed to broadside array of 33 dipoles mounted on section of 10 cm waveguide.



26 **GCA RADAR PRECISION SYSTEM** operates in the 3 cm band and provides elevation and azimuth indications on separate scopes. Output of magnetron is applied alternately to azimuth and elevation antennas by motor driven RF switch. A commutator on same shaft causes echoes to appear alternately on azimuth and elevation indicators. Uses single receiver. Both azimuth and elevation antennas scan electrically by mechanical variation of waveguide width. Elevation antenna uses 173 collinear dipoles to get .4 deg. beam, and scans through 7 deg. Azimuth antenna has 121 dipoles, .6 deg. beam and 20 deg. scan.

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ELECTRONIC INDUSTRIES

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